South Africa

SOUTH AFRICA

BY

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Preface

Since 1945 world attention has repeatedly focused on the Union of South Africa and the neighbouring British Protectorates. Relationships between European and Non-European have frequently been the subject of bitter controversy. In some quarters the policy of Apartheid has become identified with Bantu oppression. Elsewhere it has been recognized that in South Africa the complexities of all the relationships between peoples of different racial origins and widely differently economic and cultural standards are met in one country. The problems that South Africa is inevitably facing today are the problems of the world tomorrow.

To many people the Union of South Africa is synonymous with gold, a country agriculturally poor and industrially undeveloped. Such indeed was South Africa before the second world war but in the short span of twenty years the country has passed through an agrarian and an industrial revolution and is today emerging as an industrial nation, endowed with considerable natural resources. And it is very largely the large-scale drift of Non-European peoples to the White Man's towns associated with these changes which has brought to a head the many racial problems. These problems, however, can be understood only in full knowledge of the nature of the country, its resources and deficiencies, of its historic settlement by peoples of different races and of the progress made and the difficulties encountered in the major realms of economic activity – agriculture, mining, manufacturing, and trade.

This book is intended to provide this background and has been written in the earnest hope that in some small way it may quicken a deeper interest in South African affairs and lead to a wider appreciation and greater understanding of South African problems. Its territorial content has caused certain difficulties which have been resolved mainly on economic and political grounds. Thus the decision to include the Union of South Africa, South West Africa, and the British Protectorates has been governed by their close economic links today and by the way in which their histories are intertwined. The exclusion of the Rhodesias, Angola, and Mozambique has been decided by similar considerations. These territories also form part of the great South African Plateau but, since the formation of the Central African Federation, the Rhodesias have turned their face towards central Africa and are developing independently of the Union, while

Angola and Mozambique, with their Portuguese connexions, have been distinct both economically and politically. Within the area chosen for study most attention is naturally focused on the Union of South Africa, which is the most highly developed territory and the one destined to play a leading role in the affairs of the southern half of the African continent. Moreover, it is the only one for which there are adequate maps and statistics.

Abbreviations

Ann. Natal Mus. Annals of the Natal Museum, Pietermaritzburg.
Ann. Rep. Dir. Irrig. Annual report of the Director of Irrigation of the Union of South Africa, Pretoria.
Bot. Surv. of S.A. Botanical Survey of the Union of South Africa, Pretoria.
B.O.T. Board of Trade and Industries, Pretoria.
Bull. Amer. Met. Soc. Bulletin of the American Meteorological Society, Easton, Pa.
Comm. and Ind. Commerce and Industry. Official journal of the Department of Commerce and Industry, Pretoria.
Emp. For. J. Empire Forestry Journal, London.
F. in S.A. Farming in South Africa, Pretoria.
F.W. The Farmer's Weekly, Bloemfontein.
G.J. Geographical Journal, London.
G.R. Geographical Review, New York.
G.T. Geographical Teacher, Oxford.
Geog. Geography, London.
Geol. Surv. Geological Survey of the Union of South Africa, Pretoria.
J. Chem. Met. Min. Soc. S.A. Journal of the Chemical, Metallurgical and Mining Society of South Africa, Johannesburg.
J.S. Afr. Bot. Journal of South African Botany, Cape Town.
J.S. Afr. For. Ass. Journal of the South African Forestry Association, Pretoria.
J.S. Afr. Inst. Engrs. Journal of the South African Institute of Engineers, Johannesburg.
J.S. Afr. Inst. Mech. Engrs. Journal of the South African Institute of Mechanical Engineers, Johannesburg.
J.S. Afr. Vet. Med. Ass. Journal of the South African Veterinary Medical Association, Johannesburg.
Min. Surv. Mining Survey, Johannesburg.
Min. Proc. Civ. Eng. Minutes of Proceedings of the South African Institution of Civil Engineers, Cape Town.
Onderstepoort J. Vet. Sci. Onderstepoort Journal of Veterinary Science and Animal Industry, Pretoria.
Proc. Emp. Min. Metall. Cong. Proceedings of the Third Empire Mining and Metallurgical Congress, Johannesburg, 1930.

P.G.S.S.A. Proceedings of the Geological Society of South Africa, Johannesburg.

Q.J.G.S. Quarterly Journal of the Geological Society, London.

Q.J. Royal Met. Soc. Quarterly Journal of the Royal Meteorological Society, London.

Res. Mem. Ass. Sc. Workers of S.A. Research Memoranda of the Association of Scientific Workers of Southern Africa, Cape Town.

S.A. Dept. Agric. Bull. Union of South Africa, Department of Agriculture, Bulletin, Pretoria.

S.A. Dept. Agric. J. Journal of the Department of Agriculture of the Union of South Africa, Pretoria.

S.A. Dept. Agric. Sc. Bull. Union of South Africa, Department of Agriculture, Science Bulletin, Pretoria.

S.A. Dept. For. Bull. Union of South Africa, Department of Forestry, Bulletin, Pretoria.

S.A.G.J. South African Geographical Society, Johannesburg.

S.A.J. Econ. South African Journal of Economics, Cape Town.

S.A.J. Sc. South African Journal of Science, Johannesburg.

S.A. Min. (Eng.) J. South African Mining (Engineering) Journal, Johannesburg.

S.A. Min. Y.B. South African Mining and Engineering Journal Yearbook, Johannesburg.

S.A. Sc. South African Science, Johannesburg.

T.G.S.S.A. Transactions of the Geological Society of South Africa, Johannesburg.

Trans. I.B.G. Transactions and papers of the Institute of British Geographers, London.

T.R.S.S.A. Transactions of the Royal Society of South Africa, Cape Town.

Botanical Names

(COMMON NAMES IN BRACKETS)

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For help in the preparation of the maps I am grateful to Messrs J. Butters and G. Milton, Mrs N. Clunie and Miss E. Elliot, members or former members of the technical staff of the Geography Department of the University College of North Staffordshire. Special thanks are due to Mrs Mary Lambert, demonstrator in the same department, who not only assisted in the above work but was responsible for compiling the population maps.

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The Physical Background

I

Structure and Surface

The surface features of Southern Africa, as indeed of any area, are the present expression of the continual interplay between earth movements and igneous activity on the one hand and weathering and erosion on the other. Periods of quiescence and deposition have been followed by continental uplift, mountain building, and volcanic activity while all the time the agents of destruction have been busy attacking and moulding the emerging forms and burying others. Hence, in order to understand the form and features of the present landscape it is necessary to consider briefly the geological history of the area.

The greater part of Southern Africa consists of a very old continental area which has not been submerged since early Palaeozoic times. Rocks of late Palaeozoic and Mesozoic age outcrop over considerable areas of the plateau but the geologists consider that they were laid down under freshwater or continental lagoon conditions. Apart from the so-called superficial deposits, mostly of Tertiary and Recent age, covering large areas in the Kalahari, only small areas in the coastal belts are underlain by rocks of Cretaceous and later date. Apart from epeirogenetic movements, the continental plateau area has remained little disturbed since the early Palaeozoic, but around its southern margins crustal folding extending from Permian to Triassic times produced the structures of the Cape ranges. Monoclinal flexuring took place along the line of the present-day Lebombo mountains in Jurassic times and fracturing was widespread in the coastal belt during the Cretaceous period.

The Geological Evolution of South Africa

The evolution of South Africa spans an enormous period of geological time, the radioactive content of some of the oldest rocks exposed at the surface today indicating an age exceeding 1,500 million years. Nevertheless the geological make-up of South Africa is relatively simple. The major rock formations were apparently laid down during five great geological eras, each one separated from the next by prolonged periods of erosion, earth movement, or igneous activity. These five great eras are the (1) Archaean, (2) pre-Cambrian, (3) Palaeozoic pre-Karoo, (4) Karoo, and (5) post-Karoo. Today the outcrops of the rocks of each era (Fig. 1)

are remarkably continuous, occurring over extensive tracts of country where they are associated with characteristic relief features.

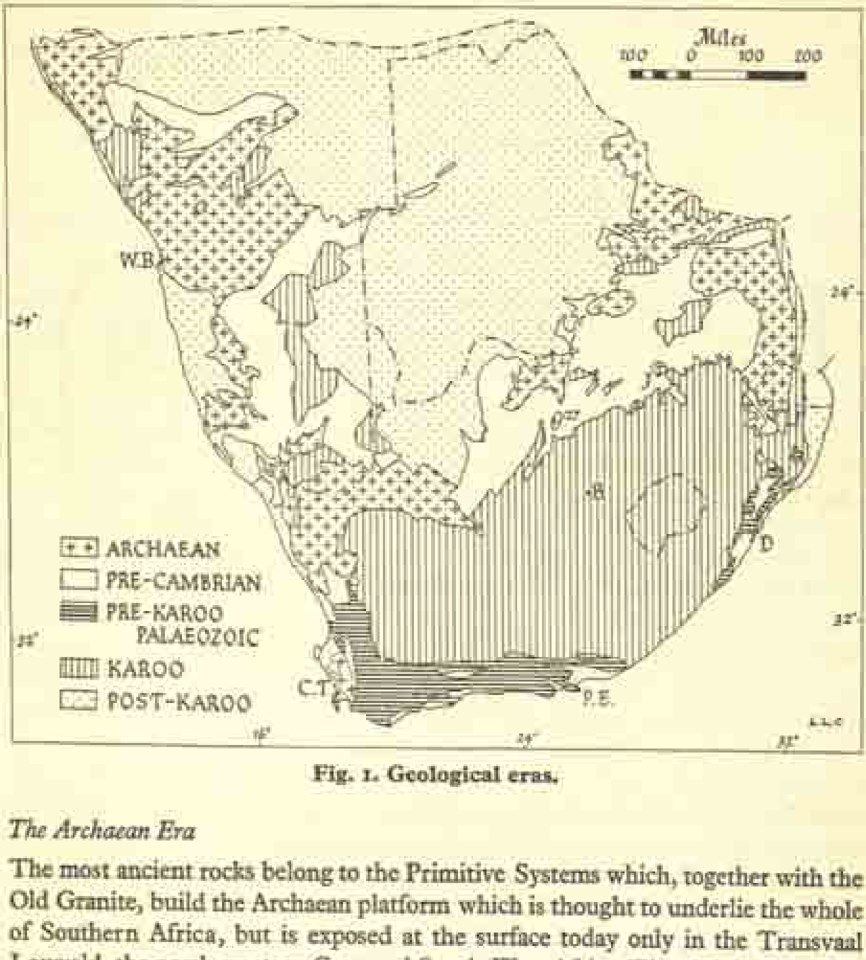


Fig. 1. Geological eras.

The Archaean Era

The most ancient rocks belong to the Primitive Systems which, together with the Old Granite, build the Archaean platform which is thought to underlie the whole of Southern Africa, but is exposed at the surface today only in the Transvaal Lowveld, the north-western Cape and South West Africa (Fig. 2). The Primitive Systems comprise highly metamorphosed sediments and igneous rocks – schists, slates, quartzites, granites, and gneisses – which show evidence of several periods of mountain building, igneous activity, and erosion before they were intruded by the Old Granite. Today they outcrop in the Damara and Khomas Highlands of South West Africa, in the western lowland of the Cape and in the Murchison range and Barberton Mountain Land of the eastern Transvaal and Swaziland. With the exception of the schists and slates these rocks are highly resistant to weathering and form striking features in the physical landscape (Plates 11 and 110). Economically they are important for in the Barberton mountains they con-

tain valuable asbestos deposits and in the Murchison range yield stibnite and gold. The Old Granite outcrops over a wider area. From it the minerals found in many of the later geological formations are thought to be derived. Its emplacement

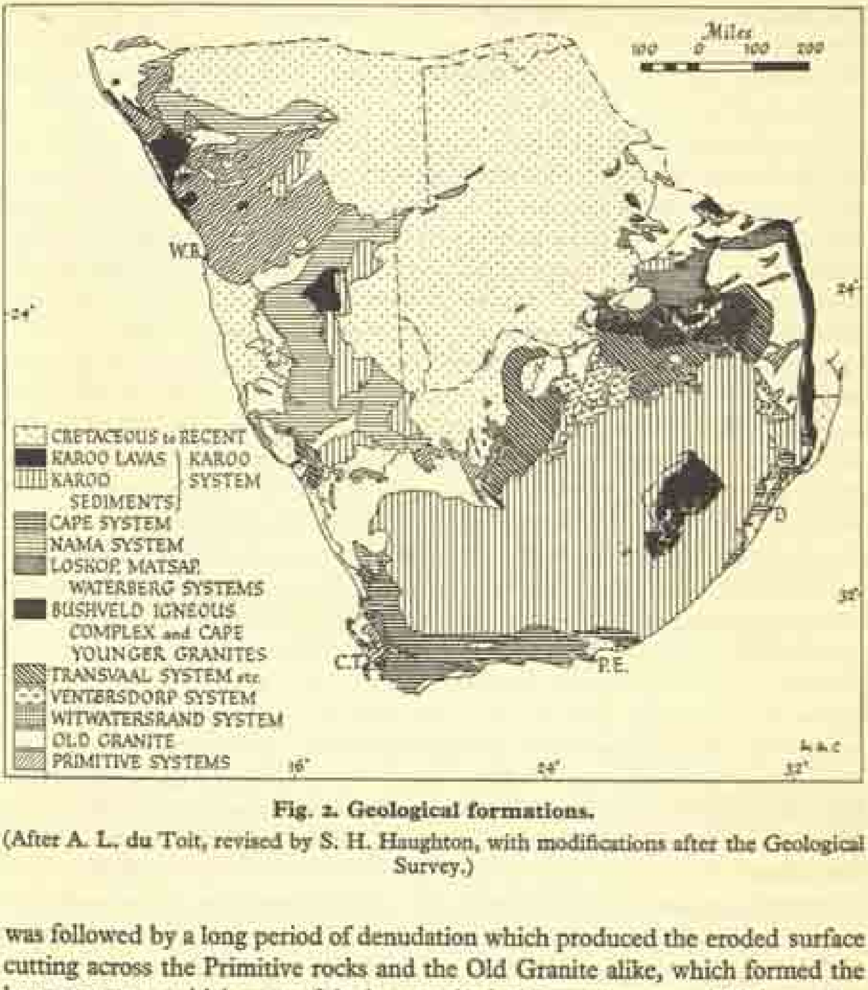


Fig. 2. Geological formations.
(After A. L. du Toit, revised by S. H. Haughton, with modifications after the Geological Survey.)

was followed by a long period of denudation which produced the eroded surface cutting across the Primitive rocks and the Old Granite alike, which formed the basement upon which most of the later geological formations were laid down. For this reason the Archaean rocks are said to form the Basement Complex.

The pre-Cambrian Era

Following this long period of erosion a shallow sea invaded the worn-down southern part of the Transvaal and northern part of the Orange Free State, thereby ushering in the pre-Cambrian era during which the rocks of the Dominion Reef, Witwatersrand, Ventersdorp, and Transvaal Systems were laid down.

The invasion of the sea created a shallow marine basin in which sediments composed of material eroded from the old Archaean land mass accumulated. These sediments now make up the conglomerates of the Dominion Reef System, and the shales, conglomerates, and quartzites of the succeeding Witwatersrand System. The former outcrops in small areas today in the eastern Transvaal and South-West Africa and is relatively unimportant. The latter which attains its maximum thickness of 24,000 feet on the Witwatersrand is, with its gold-bearing reefs, economically perhaps the most important system in the country. The first Witwatersrand sediments were for the most part shaly but about the middle of the period changed conditions brought about the deposition of the coarser materials which now form the conglomerates and quartzites, the former with gold-bearing reefs, of the Upper Witwatersrand Series. Geologists have suggested that this change was occasioned by uplift which on the one hand caused a shallowing of the sea and the formation of extensive beaches and delta flats and on the other resulted in coarser material being brought from the land mass to the margins of the deposition troughs. As the sea worked over this material the coarser pebbles, particles of alluvial gold and other heavy minerals became concentrated at the shoreline. With the landward advance of the shoreline, however, they became covered first with sandy and then with progressively finer material until the sedimentation cycle was completed. Repeated uplift resulted in the formation of a whole series of sedimentation cycles, each with gold-bearing pebble deposits at its base, until the basin of deposition was eventually drained, probably as a result of marked uplift on the north and west, and the Ventersdorp period inaugurated. This was characterized by violent volcanicity. It was accompanied and followed by the tilting and faulting of the Witwatersrand beds so that today they are disposed in the form of a broad east–west syncline, the rims of which come to the surface in the Witwatersrand in the north and the Vredefort mountains in the south, where the conglomerates and quartzites, being highly resistant to erosion, are responsible for well-marked ridges. Meanwhile probably in early Ventersdorp times the gold particles in the Witwatersrand pebble beds were recrystallized and the beds converted to the bankets in which the gold is found in a finely divided state today.

The Ventersdorp volcanic outbursts were followed by a long period of erosion during which the greater part of the land area was worn down to a flat surface. Shallow seas then reinvaded the old area of deposition and covered also large areas in the northern and western Cape. Into the basins thus formed the material later compacted to form the rocks of the Transvaal System was deposited. In the Transvaal this system comprises three distinct series, the lowest, known as the Black Reef Series, being composed mainly of tough quartzite, the middle, named the Dolomite or Campbell Rand Series, consisting of massive dolomite and the upper, called the Pretoria Series, being made up of three quartzites – Timeball Hill, Daspoort, and Magaliesberg – separated by shales and lavas. In Griqualand West the Griquatown Series of ironstones, slates, phyllites, and lavas

are equivalent in age to the Pretoria Series. The *Malmesbury Series* of the western Cape were formerly believed to be contemporaneous with the Black Reef and Dolomite Series but are now grouped with the Primitive Systems. Today the Transvaal rocks outcrop over wide areas and are economically particularly important, the Dolomite being the leading water-bearing formation in the Union and the quartzites of the Pretoria and Griquatown Series containing valuable iron ores and asbestos deposits. Scenically the Transvaal System is important, the tough Black Reef quartzite building the Drakensberg in the eastern Transvaal (see Plate 11) and the quartzites and shales of the Pretoria Series being associated in the central Transvaal with striking and remarkably continuous ridges and valleys which exert a profound influence on communications, irrigation and agriculture (see Plates 132–4). In Griqualand the resistant quartzites give rise to the Asbestos (or Kuruman) range.

The Transvaal sedimentation was terminated by great igneous activity. This actually began with lava flows in the Pretoria Series and was continued in the eruption of great thicknesses of acid lava which now form the Rooiberg felsites and granophyres and culminated in the intrusion of the great lopolith of the Bushveld Igneous Complex between the sedimentaries of the Transvaal System as base and the felsites as roof. This great intrusion took place in two stages. The first saw the emplacement of basic material, norite, in the form of a laccolite along the plane of contact between the Pretoria and Rooiberg Series, the second that of the acid 'New Red' or 'Bushveld' granite, cutting through and overlying the norite. The intrusion was of enormous dimensions. Today the Bushveld Igneous Complex outcrops over an elliptical area fully 300 miles from east to west and further sections are buried by later deposits (Fig. 224). Its thickness has been reckoned not in thousands of feet but in miles. That of the norite has been estimated at 30,000 feet, that of the 'Red Granite' at more than 8,000 feet, much having been eroded away. Following its emplacement and probably because of its great size and heaviness the intrusion subsided, causing the collapse of the Rooiberg roof and the dragging down and inward tilting of the underlying rocks of the Transvaal System. Thus was determined the general form of the Bushveld basin, with its central area occupied by igneous rocks, here and there capped by remnants of the old roof and here and there enclosing unconsumed portions of

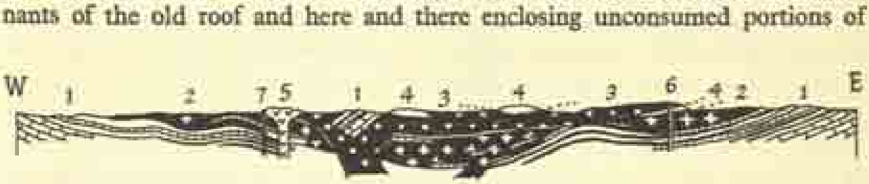


Fig. 3. Diagrammatic section through the Bushveld Lopolith from west to east (distance nearly 300 miles).

1. Transvaal system invaded by sills of diabase (black), forming the 'floor', which is broken and floated up in places. 2. Norite. 3. Red granite. 4. Rooiberg Series forming the disrupted 'roof'. 5. Pilansberg volcanic centre. 6. Spitzkop volcanic pipe. 7 Kimberlite pipe. (After A. L. du Toit.)

Transvaal rocks, and the rim formed by beds of the Transvaal System dipping towards the centre of the basin (Fig. 3). The emplacement of the Bushveld Igneous Complex was accompanied by considerable mineralization. Included in the norite itself are sheets of chromite and platinum concentrated by magmatic gravity separation. The Rooiberg roof contains tin ores. It was followed by minor volcanic activity which produced the lavas and syenites of the Pilansberg.

The intrusion of the Younger Granites in the Cape may have occurred

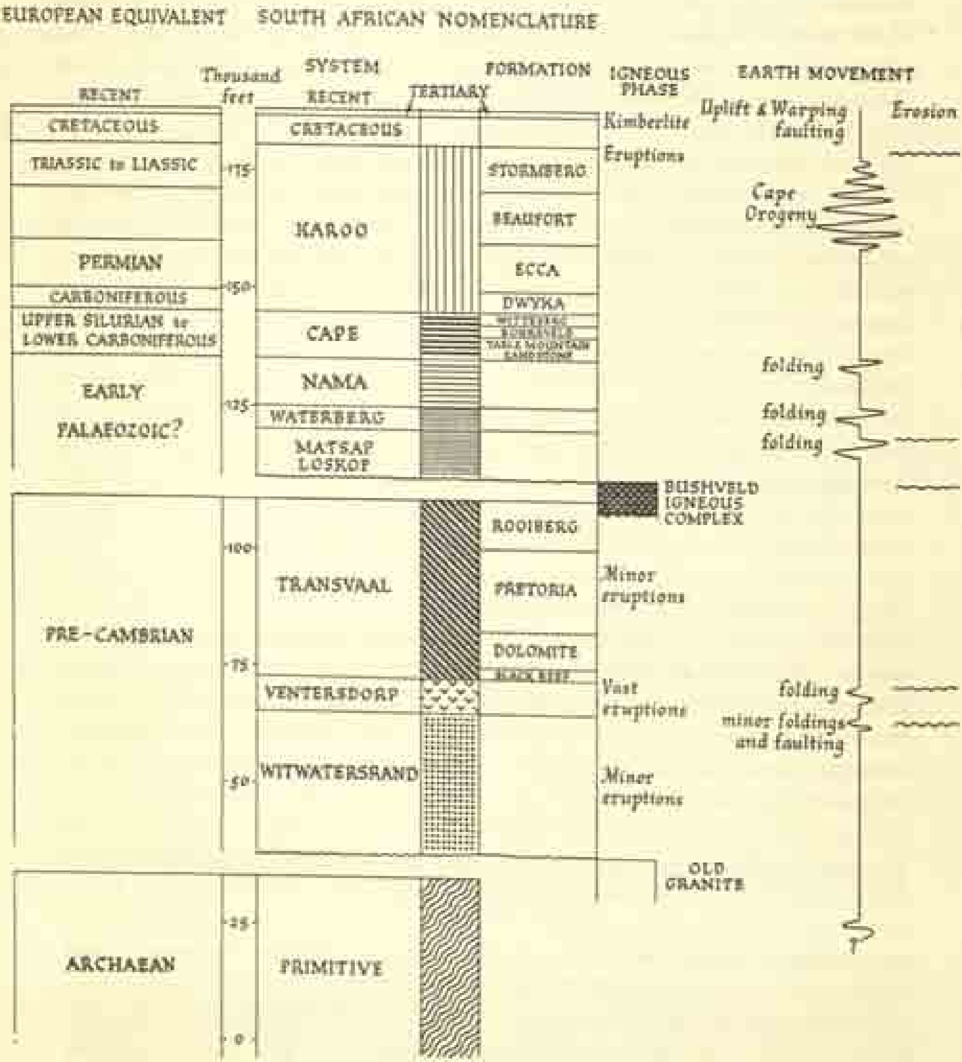


Fig. 4. The geological time scale.

during the same period as the emplacement of the Bushveld Igneous Complex in the Transvaal.

A period of extensive planation followed the intrusion of the Bushveld Igneous Complex so that when sedimentation was resumed, the lowermost beds transgressed over rocks ranging in age from the 'Bushveld Granite' to the Old Granite. These beds now form the quartzites, grits and conglomerates of the Loskop-Matsap Systems which were strongly folded and eroded and then buried by the sediments of the succeeding Waterberg and Nama Systems, now considered by some geologists to be of equivalent age. The Waterberg beds were apparently laid down under desert conditions and consist of thickly bedded quartzitic sandstones and conglomerates. Today they occur principally in the Soutpansberg and Waterberg plateaux where, horizontally disposed and attaining a maximum thickness of over 9,000 feet, they form extensive plateaux terminated by steep escarpments. Economically their importance lies in their function as an aquifer feeding perennial streams. The Nama System, comprises quartzitic sandstones and shales of continental origin, separated by limestones and shales laid down in shallow seas which had once again formed over the old western area of deposition. Their deposition marked the end of one of the major phases in the geological history of South Africa for thereafter the plateau remained dry land. It seems likely, however, that the pre-Cambrian era had already closed for the first recognizable fossils occur in the Nama System which has thus been tentatively correlated as early Cambrian. European readers will no doubt be amazed by the fact that after the deposition of more than 100,000 feet of sedimentary rocks, the Palaeozoic era is only just entered. Indeed pre-Cambrian rocks make up more than half the total thickness of the sedimentary succession in South Africa (Fig. 4), and the era is remarkable for its complexity as well as length.

The Palaeozoic pre-Karoo Era

The beginning of the Palaeozoic era was marked by the development in the south of a fluviatile basin which gradually deepened to form the geosyncline in which the sediments which now form the Cape System accumulated. At first coarse material was dropped in the relatively shallow waters. This has since consolidated into the Table Mountain Sandstone, a tough quartzitic sandstone attaining a maximum thickness of 5,000 feet. As the geosyncline deepened, fine sediments subsequently compacted to the Bokkeveld shales were laid down. Finally the period of sedimentation concluded with the deposition of the material from which the shales, sandstones, and quartzites of the Witteberg Series, which like the Bokkeveld Series has a thickness of 2,500 feet, have been formed. Due to its unfossiliferous nature, the precise geological age of the Table Mountain Sandstone is not known but both the Bokkeveld and Witteberg Series contain fossils of Devonian age and geologists consider that the Cape System spans the period from the Upper Silurian to Lower Carboniferous times. The rocks of the Cape System were subsequently folded in Karoo (Permo-Triassic) times and thereafter

subjected to weathering and erosion. Today very little of the Witteberg rocks remains, the Bokkeveld shales are preserved only in mountain basins and valleys where they weather to good soils and are therefore economically very important; the Table Mountain Sandstone outcrops in the cores of the anticlines where its toughness and thickness are responsible for the magnificent scenic features of the Cape mountains.

The Karoo Era

By the close of Witteberg times the Cape geosyncline had become comparatively shallow. To the north the greater part of the area extending from South West Africa through the Orange Free State to Natal was one of low relief but farther

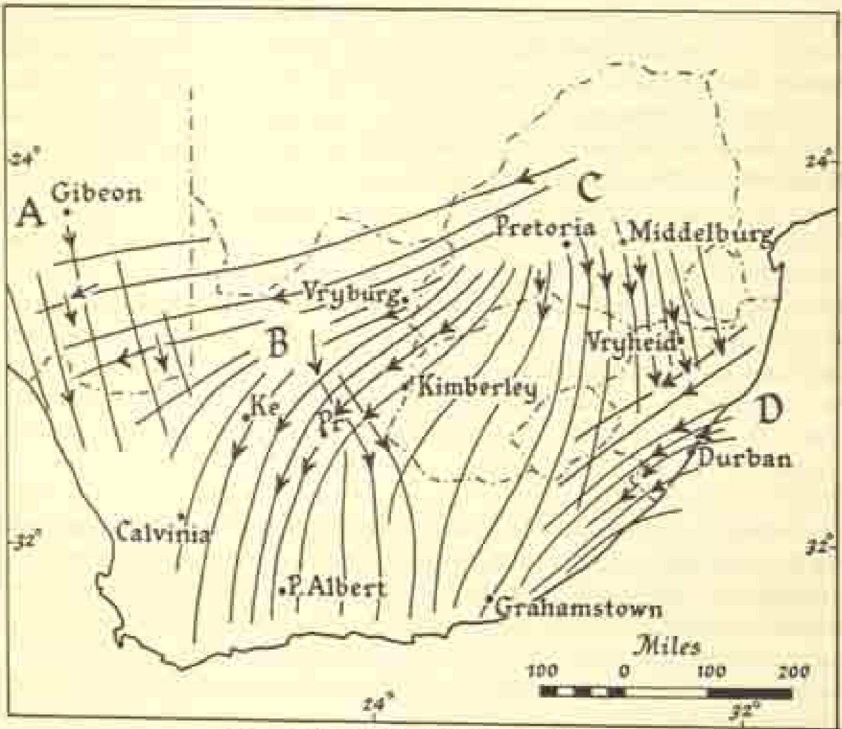


Fig. 5. The Carboniferous glaciation.

The arrows indicate observed glacial striae, the continuous lines show the direction of ice movement from the main ice caps in South West Africa (A), Griqualand West (B), the Transvaal (C), and Natal (D). (After A. L. du Toit.)

north over the Transvaal, Griqualand West and the Windhoek highlands the land rose to form highland areas. Here a lowering of the temperatures and the formation of ice caps ushered in the first period, the Dwyka, of a new era, the Karoo. The Dwyka (Carboniferous) period was one of prolonged and intense glaciation.

Today striated bed rock, overlain by tillite, indicates that the glaciers moved radially southwards from centres of dispersion in the central Transvaal, West Griqualand, South West Africa, and Natal (Fig. 5). The tillite, representing the ground moraine left by the retreating glaciers, attains its maximum thickness in the southern Cape near the probable southern limit of the ice, and is overlain by Dwyka shales considered to represent post-glacial silts. With the retreat of the glaciers the climate ameliorated while the area of low relief lying between the old Cape geosyncline and the high ground north of the Limpopo river was alternatively just submerged and just exposed to the atmosphere. Early in Ecca (Permian) times flats, deltas and swamps developed along the northern margin of the old Cape geosyncline. Here forests – the glossopteris flora – flourished until killed by submergence when the decaying vegetation was slowly buried by sediments brought down by the rivers from the high land to the north-east and conditions suitable for forests transferred into the higher ground. By Middle Ecca times these conditions extended northwards into the Transvaal and in Upper Ecca times into Rhodesia. They resulted in the formation of the alternating coal seams, sandstones and shales which now make up the coalfields of the Union and Southern Rhodesia, with the main coal seams in the Middle Ecca but characteristically occurring at geologically higher horizons northwards.

By the close of Ecca times the Cape geosyncline had become almost completely filled in and in the succeeding Beaufort (Permian to Triassic) period folding began. This reached its acme late in the same period although it continued until late in Karoo times. The compression was directed mainly from the south and south-west so that the Cape sediments were gradually pushed towards the margin of the old continent which acted as a rigid block. It resulted in the formation of the Cape ranges of which the Cedarbergen trending north-north-west–south-south-east and the Swartbergen and Langebergen with east–west axes are the most prominent remnants. The two sets of folds met in a syntaxis in the south-western Cape where the relief is most complex today. Along the Natal coast between Durban and Mount Edgecombe and again near Port Shepstone synclinal structures in lower Karoo rocks suggest the former presence of a similar but slightly younger folded belt which disappeared perhaps with the break-up of Gondwanaland.

The rising of the Cape mountains cast a rain shadow over the interior lands thereby changing the conditions for deposition. This is revealed today in the abrupt change in the lithology of the rocks which has led to the separation of the Karoo System into two divisions – a Lower and an Upper – the former including the Dwyka and Ecca Series and spanning the Carboniferous-Permian periods, and the latter the Beaufort and Stormberg Series ranging from Permian to Lower Jurassic.

Throughout the Karoo period the area broadly coincident with the present plateau remained dry land and the pre-existing topography was gradually buried by deep sediments laid down more or less horizontally. Under the semi-desert or

desert conditions of the Beaufort and Stormberg periods these were mainly sands which have since been compacted into sandstones of which the Cave Sandstone is particularly thick and well developed; as its name suggests, however, it is relatively soft and with weathering, caves readily develop within it. By the close of the Triassic (within the Stormberg) South Africa was a vast sand-covered waste which was then flooded by vast sheets of lava which issued from numerous fissures and also from vents in Basutoland and the Lebombo range and probably covered the greater part of the eastern half of South Africa. At the same time an extensive and intricate system of dolerite dykes and sills was intruded into the rocks below. Some of the dykes may occupy the fissures through which the lava reached the surface.

Owing to the changing conditions under which the Karoo rocks were laid down the distribution, thickness and character of each series is variable. Generally speaking the succession is most fully developed and attains its maximum thickness in Basutoland and the adjacent parts of the eastern Cape, which probably mark the centre of the area, perhaps basin, of deposition. It thins out rapidly northwards. The Dwyka, Ecca, and Beaufort Series are well developed in the southern Cape but thin out rapidly northwards. Coal seams are poorly represented in the Ecca rocks of the southern Cape. They are best developed in Natal and the Transvaal but in the latter province the lower Ecca shales are missing and the coal seams are present only in what are believed to be basins in the pre-Karoo floor (see ch. 23). The Stormberg Series attains its maximum thickness in Basutoland. It thins northwards and is preserved only on the Lebombo range, in the Springbok Flats and in the Limpopo depression in the Transvaal. It is absent from the Cape but the numerous dykes and sills suggest a former lava cover. Economically and scenically the Karoo system is highly important. It contains the major coalfields of South Africa. The Stormberg lavas capping Cave Sandstone build the great wall of the Natal Drakensberg and the intrusive sills being more resistant to erosion than the country rock form the Great Escarpment in the southern Cape and are responsible for the flat-topped kopjes of the Karoo (Plate 119).

The post-Karoo Era

A long period of erosion and crustal adjustment followed the outpouring of the Karoo lavas. By the close of Jurassic times folding had ceased in the southern Cape and the anticlines had been reduced by erosion and the synclines filled with the debris which now form the lower beds of the Cretaceous System. Meanwhile in Liassic times monoclinal flexuring took place along the line of the Lebombo mountains, where the entire Karoo succession was given an easterly tilt from 5° to 45° but more usually about 12°. The monocline which lies west of the folded structures in the Karoo rocks may be traced southwards to the mouth of the Umtata river in Pondoland. Its formation was attended and followed by faulting which near Port St Johns continued into Lower Cretaceous times. In mid-Cretaceous times fracturing in the southern Cape produced the great

Worcester fault which, with a maximum throw of 12,000 feet along the Swartbergen, may represent a continuation of the Lebombo line of movement. Indeed it seems likely that both the monoclinal flexuring and the faulting were associated with general uplift in the continental mass which began at an earlier date in the north. This uplift was probably associated with and may even have initiated vast continental movements. Many geologists believe that until the close of Jurassic

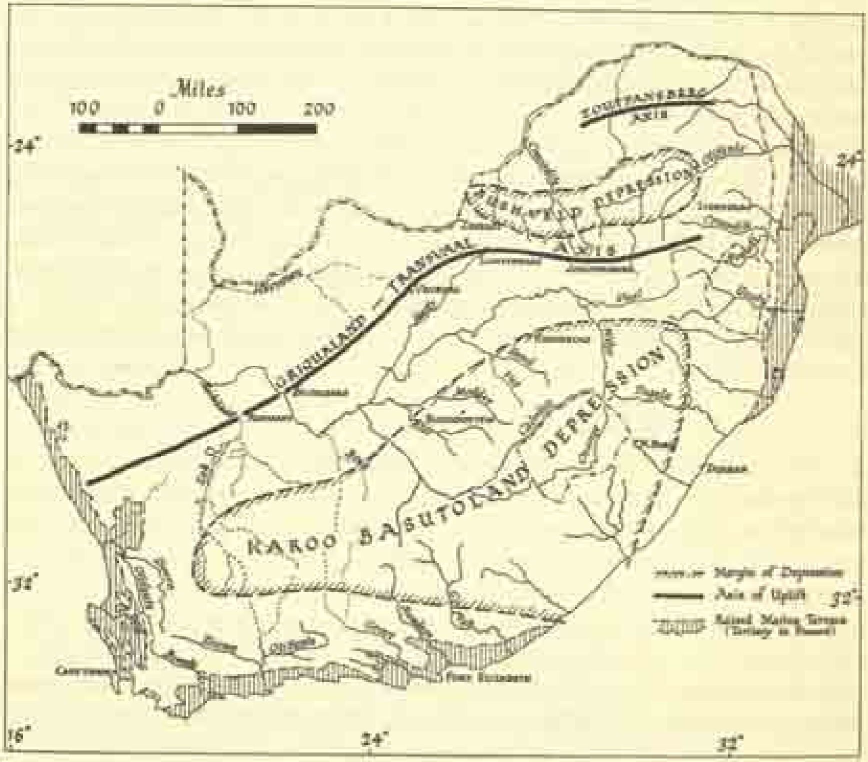


Fig. 6. Tertiary warpings.
(After A. L. du Toit, courtesy *South African Geographical Journal.*)

times South Africa formed part of Gondwanaland and they suggest that the widespread faulting occurring from late Jurassic to mid-Cretaceous times and bringing into being the Limpopo trough, the great rift valley of East Africa and a host of minor features in the Union, marked the breaking-up of this super-continent. At the same time the folded belt of Natal disappeared. Thereafter South Africa began to assume its present outline. Indeed only very limited areas of Tertiary and later rocks have been added to the Cretaceous coastline, a feature explained by the progressive deepening of the waters offshore following the break-up of Gondwanaland.

Economically the Cretaceous crustal movements were highly important for they were accompanied by the widespread eruption of kimberlite pipes, some of which, being diamond bearing, have played a very important part in the development of South Africa.

From Jurassic times onwards South Africa appears to have suffered several cycles of prolonged planation separated by periods of uplift and warping. The Tertiary isostatic movements which produced upwarping around the coastal periphery and along the Griqualand–Transvaal and Soutpansberg axes and caused the relative depression of the Karoo-Basutoland area (Fig. 6) had the most far reaching effects. Following the deposition of clays, sands and gravels in the depression now occupied by the Kalahari, the sharpening of the rainshadow in the interior as a result of the Tertiary warpings led to increasing desiccation. During the late Tertiary the formation of surface limestone (calcrete), surface quartzite (silcrete) and lateritic ironstone (ferricrete) became widespread. Finally deposition culminated with the spreading of Kalahari sand over vast areas in the interior during the early Pleistocene. At the same time around the coast intermittent emergence, associated with repeated continental uplift and producing a series of raised beaches, occurred until the present outline of the subcontinent was attained.

The Evolution of the Physical Landscape

An understanding of the present physical landscape of South Africa demands due consideration of the processes fashioning the surface, the underlying geological structure and the stage reached in the present and in earlier cycles of erosion. The keys to this understanding lie in the recognition of the major landscape provinces and of the relationship of the river systems to the surfaces they drain.

Four major landscape provinces may be recognized, two of them on the great plateau and two within the marginal belt (Fig. 7). Occupying the greater part of the plateau is the remarkably level country which is underlain by horizontal strata of the Karoo System and may be termed the Karoo province. A second landscape province is formed by the topographically diversified country of the Transvaal and northern Cape which coincides with that part of the plateau from which the Karoo cover has been stripped away and the ancient rocks of the pre-Karoo surface below exposed. Below the Eastern Escarpment the belt of dissected country developed partly on Karoo and partly on pre-Karoo rocks constitutes a third province. Contrasting sharply with it the Cape Folded Belt, built of rocks belonging to the Cape System and characterized by remarkably continuous ridges and longitudinal valleys paralleling the coast, forms the fourth.

These landscape provinces are distinguished from one another not only by marked contrasts in surface form but also by striking differences in the drainage pattern, in the form of the river valleys and in the relationship between the river systems and the surfaces they drain. Before considering these differences the alignment of the main watershed between the rivers draining directly to the Indian

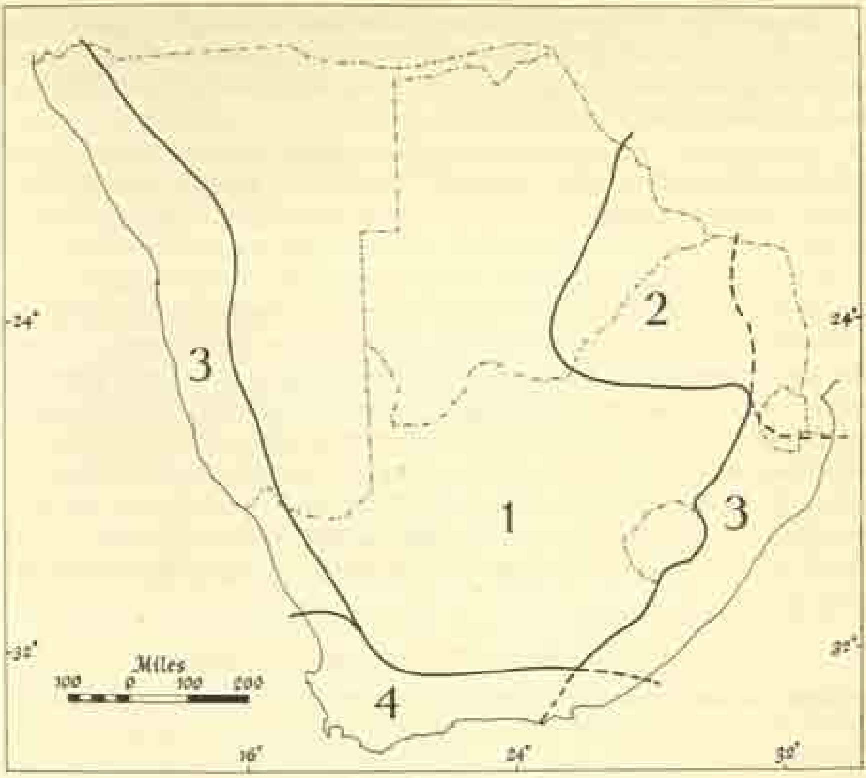


Fig. 7. Landscape provinces.

1. *Karoo province.* Developed mainly over Karoo and post-Karoo rocks and characterized by level surfaces and accordant drainage. 2. *Pre-Karoo province.* Developed mainly over pre-Karoo rocks and characterized by diversified relief and superimposed drainage. 3. *Eastern and Western Marginal provinces.* Relief and drainage features associated with scarp retreat and pediplanation. 4. *Cape Folded province.* Structural relief features with drainage becoming adjusted to structure in a folded mountain belt.

and Atlantic oceans and those draining to the Orange river should be noted (Fig. 8). Generally speaking this watershed coincides with the Great Escarpment but in the southern Transvaal it swings westwards following the line of the Griqualand-Transvaal axis of uplift.

In the Karoo province the drainage is to the Orange river and shows a dendritic pattern. The river gradients are gentle and the smoothness of the thalwegs is interrupted only where dolerite dykes outcrop. The drainage is accordant with the underlying structure. By contrast on the Transvaal pre-Karoo surface it appears to have been superimposed from a former Karoo cover (see page 640). The rivers flow northwards to the Limpopo and in so doing cut across the east-west trending ridges and valleys of the Bankeveld, trenching the former in a series of poorts (Plates 1 and 132). Where these rivers traverse the Soutpansberg

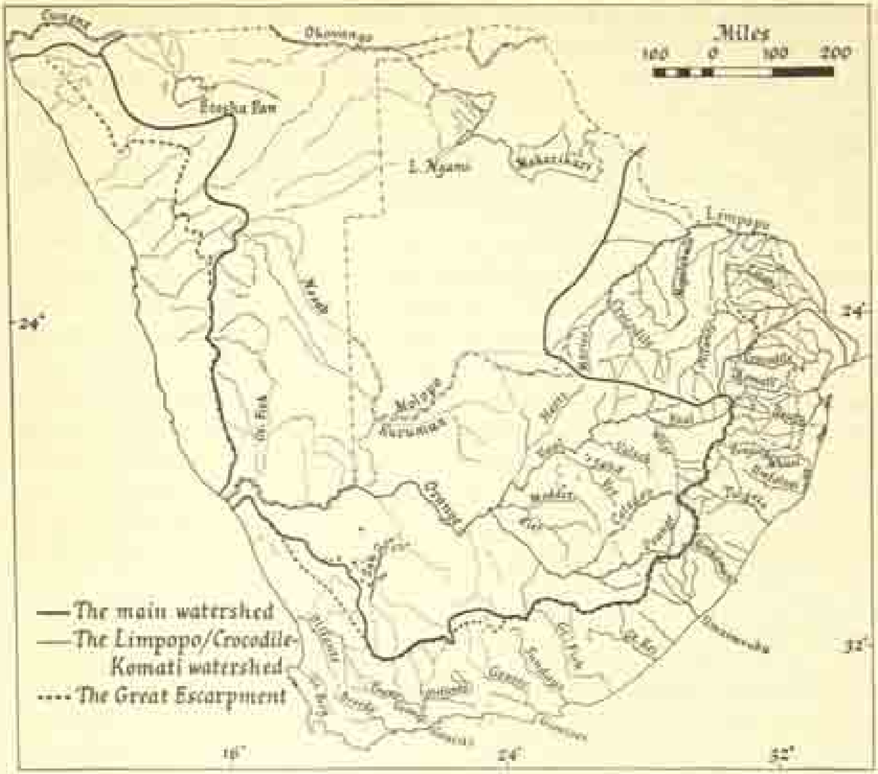


Fig. 8. Drainage. Rivers and watersheds.
Those streams shown by dotted lines are intermittent.

and also where the Orange river leaves the Karoo cover and encounters the Griqualand-Transvaal axis of uplift, the drainage appears to be antecedent to the uplift. Thus in the pre-Karoo province the drainage is inherited from a Karoo cover and pre-dates the Tertiary upwarpings. In the marginal belt of Natal and the eastern Cape most of the major rivers rise along the Escarpment and follow a more or less direct course to the sea. They are characterized by stretches of gentle gradient interrupted by falls, which in many cases occur over the outcrops of dolerite sills (Plate 5). In the eastern Transvaal, however, the major rivers rise along an indeterminate watershed on the Highveld plateau, with its cover of Karoo rocks, cross the Great Escarpment in waterfalls (Plate 2) and then follow courses in the Lowveld which are quite unrelated to the underlying structure (Plates 3 and 4). In the south-western part of the Cape Folded Belt the drainage conforms to the folding with the main rivers occupying the major syclines. In the southern Cape, however, the major tributaries follow the synclinal structures but the main rivers rise along the Great Escarpment well to the north of the Cape

ranges which they trench in narrow poorts on their way to the southern ocean. Here and in the south-eastern Cape the main rivers rise on Karoo beds where they possess a dendritic tributary pattern. In the latter region too they cut through the Cape ranges in narrow defiles before opening out on the coastal foreland to reach the sea.

From these features it seems clear that in the evolution of the present landscape the Karoo surface has played a vital role. The separation of South Africa from the rest of Gondwanaland must also have been of fundamental importance and Tertiary earth movements appear to have introduced modifying influences.

The processes responsible for sculpturing the present surface form are complex. In approaching their study it is important to remember two outstanding features of the present landscape – the frequency of extensive remarkably level surfaces in many parts of the country and elsewhere, the striking way in which geological structure and the character of the underlying rocks are expressed in the surface form. The first may be related to a complex geomorphological history involving several cycles of erosion, with these surfaces representing the remnants of former peneplains or pediplains.* The second could be due partly to physiographic youth and partly to the dominance of mechanical over chemical

* The term *peneplain* was first used by W. M. Davis to describe the surface features of the Connecticut valley: 'The faulted ridges of the Connecticut must have been reduced to a low base-level plain . . . a nearly featureless plain, a "peneplain", as I would call it, at a low level.' Later he refers to the 'featureless surface or peneplain of its old age' ('Topographic development of the Triassic formation of the Connecticut valley'. *Am. J. Sc.*, Third Series, Vols 37–8, 1880, pp. 423–34).

The term *pediplain* was proposed by J. H. Maxson and G. H. Anderson to describe 'widely extending rock-cut and alluviated surfaces . . . formed by the coalescence of a number of pediments and occasional desert domes' ('The terminology of surface forms of the erosion cycle', *J. of Geol.*, Vol. 43, 1935, pp. 88–96).

The term *pediplane* was first used by A. D. Howard 'as a general term for all degradational piedmont surfaces produced in arid climates which are either exposed or covered with a veneer of contemporary alluvium no thicker than that which can be moved during floods'. He embodied under pediplanation all the processes by which pediplanes are formed ('Pediment passes and the pediment problem.' *J. Geomorphology*, Vol. 5, 1942, pp. 2–31 and 95–136).

The terms pediplain and pediplane are regarded as synonymous with the former enjoying the wider usage.

L. C. King regards the pediplanation cycle as one 'under which the dominant forces operating are, in order of their appearance, river incision, scarp retreat and pedimentation'. 'From the steep hillside sweeps outward a flatter pediment with a surface concave upwards. Normally veneered with detritus, both residual and transported, pediments are essentially rock-cut features. Pediments originate and grow by retreat of the hillslopes above them'. 'Throughout maturity opposing scarps meet from the opposite sides of hills, which are thereby rapidly lowered. The inselbergs disappear, relief decreases markedly and with coalescing of the ever-increasing pediments a bevelled landscape of low relief and multiconcave form, a pediplain, is produced' (*South African Scenery*, Edinburgh, 1951, 2nd edition).

For considerations of the peneplain concept, the pediment problem and the arid erosion cycle, see William D. Thornbury, *Principles of Geomorphology*, New York, 1954.

For a consideration of the landscape cycle in Southern Africa, see L. C. King, *South African Scenery*, 1951.

weathering – a result of the relatively dry climate. Certainly their interpretation must be sought in the major processes fashioning the surface and the stage reached in the erosion cycle.

The two leading South African geomorphologists – J. H. Wellington and L. C. King – both accept the surface formed by the Karoo sedimentation and volcanicity as the initial one for the interpretation of the present landscape. They differ, however, in their concepts of the processes which have been and still are fashioning this landscape. King believes that the landscape has been and is being fashioned by pediplanation, a concept envisaging two surfaces, an upper and a lower, separated by a scarp which under the influence of headward river erosion, is in process of retreat. Every rise of the land relative to sea level (base level) initiates the development of a new surface which gradually eats its way inland. Thus a series of such surfaces, succeeding one another in time and development, may appear (see Plates 99–101), each growing by encroachment upon the features of its predecessors and in turn being encroached upon by the features of the succeeding cycle as headward erosion brings about the retreat of the scarps. He recognizes four major cyclic land surfaces in Southern Africa, giving them the names in descending order, Gondwana, African, Victoria Falls, and Congo (Fig. 9). The first-named surface receives its name because King believes that it was cut not across Africa alone but across Gondwanaland. He believes further that the break-up of this super-continent was responsible for the inititation, in late Cretaceous times, of the African cycle and that the Tertiary warpings, which he dates as late Oligocene – early Miocene, ushered in the Victoria Falls cycle. The last mentioned was the first of a number of riverine cycles penetrating up the major rivers. The Lowveld of the Transvaal and Swaziland is ascribed to it. It was succeeded by the Congo cycle, introduced by zonal arching, and other riverine cycles represented in the lower stream courses by terraces (see Plate 100). In addition to these major surfaces King recognizes the remnants of another and earlier surface in the bevelled tops of the Basutoland mountains. This he regards as of Jurassic age. In every case he has dated the surfaces from studies of the post-Karoo sediments of the coastal plain and Kalahari, correlating any gaps in the sedimentation record 'with the inception and termination of erosional cycles'.

Wellington believes that the accumulation of Karoo sediments and the outpouring of the Stormberg lavas produced an extensive highland area and that the present landscape has been fashioned by the progressive and continuous reduction of this surface by the action of the rivers flowing to the Orange river and to the east coast. The rate at which this has taken place has been conditioned by the resistance to erosion of the rocks over which the rivers have flowed and by the intervention of the Tertiary earth movements. Wellington suggests that at first, when the Karoo rocks alone were involved, the rate was relatively rapid, but that later it was greatly retarded by the uncovering of resistant pre-Karoo rocks in the lower courses of the rivers. He instances the uncovering of hard pre-Karoo rocks

by the Orange river between Prieska and Upington – where the river crosses the Griqualand-Transvaal axis of uplift – and further suggests that this produced a local base-level which was responsible for a certain amount of planation upstream, possibly accounting for the formation of high-level terraces along the river above Prieska and for the Kaap plateau erosion surface.

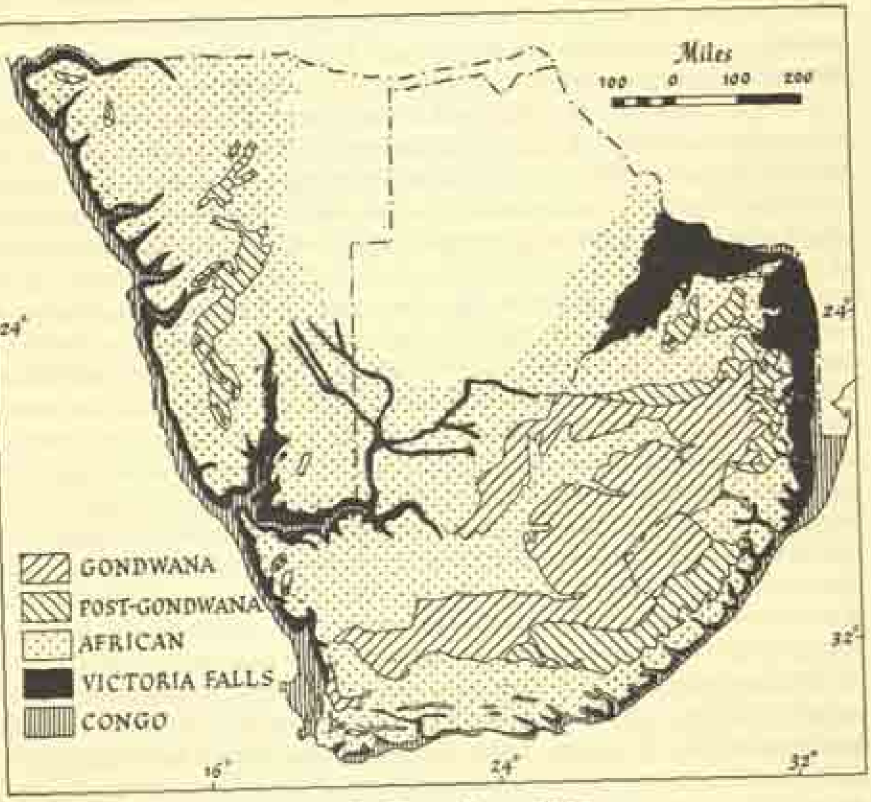


Fig. 9. Cyclic erosion surfaces.
(After L. C. King.)

Wellington considers that the Basuto highlands represent a relict of the initial Karoo surface. He recognizes the existence of a Gondwana surface north of the Union but maintains that continuous erosion since Jurassic times makes the contention of King that large areas of the plateau represent remnants of a Gondwana surface highly improbable. He acknowledges the Miocene peneplain (i.e. King's African surface) to be the most clearly established of all the erosion surfaces recognized in Southern Africa, but doubts whether an extensive true Miocene peneplain ever existed on the plateau of the Union. Finally Wellington indicates that he believes the separation of Madagascar and the opening of the

Mozambique channel at the close of Jurassic times and the Limpopo trough-faulting in mid-Cretaceous times to be of fundamental importance for these events he considers led to the reversal of the northern sub-continental drainage from Kalahariwards to Mozambique Channel-wards in mid-Cretaceous time. He believes that headward erosion into the Jurassic, i.e. Karoo, surface by tributary streams of the new drainage lines probably began in Cretaceous times and that the desiccation of the Kalahari basin, accompanied by the widespread accumulation of aeolian sands, followed the drainage diversion and the intensification of the rain shadow by the uplift of the eastern rim in Miocene times.

In the opinion of the present writer the views of King and Wellington are not necessarily conflicting but their respective relevance varies from one physiographic province to another. There appear to be three essential elements in the landscape – extensive level surfaces, well-marked escarpments, and superimposed drainage – the first mentioned a feature of all physiographic provinces except the Cape Folded Belt, the second especially characteristic of the lands below the Eastern Escarpment and the third of the Transvaal pre-Karoo surface. As both King and Wellington agree, the present landscape appears to have been fashioned from a relatively uniform surface formed by the accumulation of Karoo sediments and lavas before the break-up of Gondwanaland. On this surface an initial drainage system was developed and began to reduce it. The drainage was Kalahariwards. Between late Jurassic and mid-Cretaceous times monoclinal flexuring near the present east coast, the break-up of Gondwanaland and the formation of the Limpopo trough inaugurated drainage towards the Indian ocean and brought into being an eastern watershed and the Vaal-Limpopo watershed. The major river systems of the present day appear to have been initiated on the Karoo cover about this time and, since the Orange river trenches the Griqualand axis of uplift and the Limpopo tributaries trench the Soutpansberg axis, before the Tertiary warpings. The eastern watershed, coinciding with the monocline, acquired the form of an escarpment. This retreated westwards as a result of the headward erosion of the east coast rivers, becoming steeper and more clearly defined as structures involving resistant rocks overlying softer beds in horizontal or gently inclined strata were uncovered. Thus the Great Escarpment of the Natal Drakensberg was formed.

The Tertiary warpings had far-reaching effects on the drainage. By uplifting the margins of the plateau and thereby causing the basining of the Karoo-Basutoland area and the Bushveld basin, they weakened the gradients along the Orange river and its major tributaries above Prieska and along the streams in the central Bushveld. At the same time the upwarp along the Transvaal axis invigorated the headwater streams of the Vaal and Limpopo and that along the eastern margin of the sub-continent gave added power to the streams draining to the Indian ocean. Thereafter the processes sculpturing the surface appear to have differed in their relative importance in the several provinces. In the basined areas planation was locally important. In the southern Transvaal, as the in-

vigorated streams stripped the Karoo cover from the vicinity of the Transvaal axis of uplift so drainage superimposition and adjustment to structure became the dominant processes bringing into being a landscape of diversified relief. By contrast in the lands below the Great Escarpment the relatively powerful streams continued to erode headwards, causing the retreat of Great Escarpment; at the same time with each rise of the continental mass relative to sea level new escarpments were formed. In this way a series of escarpments came into being, each one retreating westwards parallel to the others by headward river erosion. Thus scarp recession became the dominant process fashioning the landscape. In the eastern Transvaal, however, where the major rivers originate on the Karoo surface west of the Great Escarpment which is negotiated by waterfalls, the present landscape appears to have been sculptured by the processes involved in both drainage superimposition and scarp recession.

The landscape in the Cape Folded Belt has evolved in a different way. Today the anticlines form the ranges and the synclines the major valleys but of the rocks involved in the original folding little trace of the Witteberg quartzites remain, the Bokkeveld shales are preserved only in the synclines and the Table Mountain Sandstone forms the anticlines. The present landscape is resequent, i.e. the present surface like the original one conforms to the underlying structures, but doubtless at least two erosion cycles have gone to its fashioning. It is believed that there was a general tendency for the initial rivers to conform to the alignment of the folds but that after the longitudinal (east–west) valleys south of the Swartberge-Suurberge line had become deeply filled with Cretaceous deposits, cross warpings diverted the drainage southwards and that, aided by increased gradients following the elevation of the continent, the rivers were able to maintain their southerly courses, deepening their valleys and cutting through the Cape ranges. In these sections the drainage is thus superimposed from a Cretaceous cover. The possibility that it may be superimposed from a Karoo cover, particularly in the south-east, should not be overlooked for here the folding ceased before the deposition of the uppermost Karoo beds – the Stormberg Series, whose outcrop was probably formerly much more extensive. More recently considerable adjustments to structure, with the tributaries etching out their valleys along the weaker strata, have occurred.

As its edge retreats under the attack of the forces associated with drainage superimposition, scarp recession and adjustment to structure, the Karoo surface itself is being slowly reduced by subaerial denudation and normal stream erosion. From an overall assessment of present surface features and of the processes actively shaping the landscape it would seem that King's concept offers the best interpretation of the conditions in the eastern marginal belt and that of Wellington for the great plateau and the diversified country of the southern Transvaal, with the Cape Folded Belt as an area in which superimposition and adjustment to structure is accepted.

The Physiographic Regions

The outstanding relief feature of Southern Africa is the Great Escarpment which divides the sub-continent into two major physiographic provinces – the plateau, characterized by extensive level surfaces, and the marginal lands, more dissected and in places exhibiting acute relief features.

The Great Escarpment

The Great Escarpment is a geomorphological feature sculptured in rocks of diverse nature and greatly varying age by the headward erosion of streams cutting back into the plateau. It is naturally boldest where structures composed of resistant rocks overlying weaker ones have been encountered but in addition, as L. C. King has pointed out, the height of the scarp face is closely related to the nature and age of the two surfaces it separates.

Over the greater part of its length the Great Escarpment is cut into Karoo rocks whose succession is most complete in Basutoland (see p. 12), where the

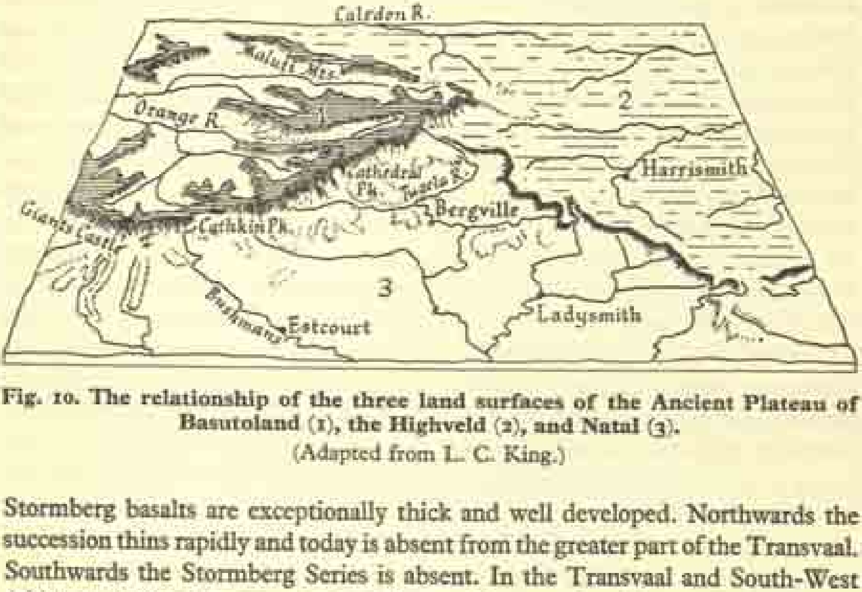


Fig. 10. The relationship of the three land surfaces of the Ancient Plateau of Basutoland (1), the Highveld (2), and Natal (3).
(Adapted from L. C. King.)

Stormberg basalts are exceptionally thick and well developed. Northwards the succession thins rapidly and today is absent from the greater part of the Transvaal. Southwards the Stormberg Series is absent. In the Transvaal and South-West Africa the Great Escarpment is cut in pre-Karoo rocks although in the former area Karoo beds may originally have been involved.

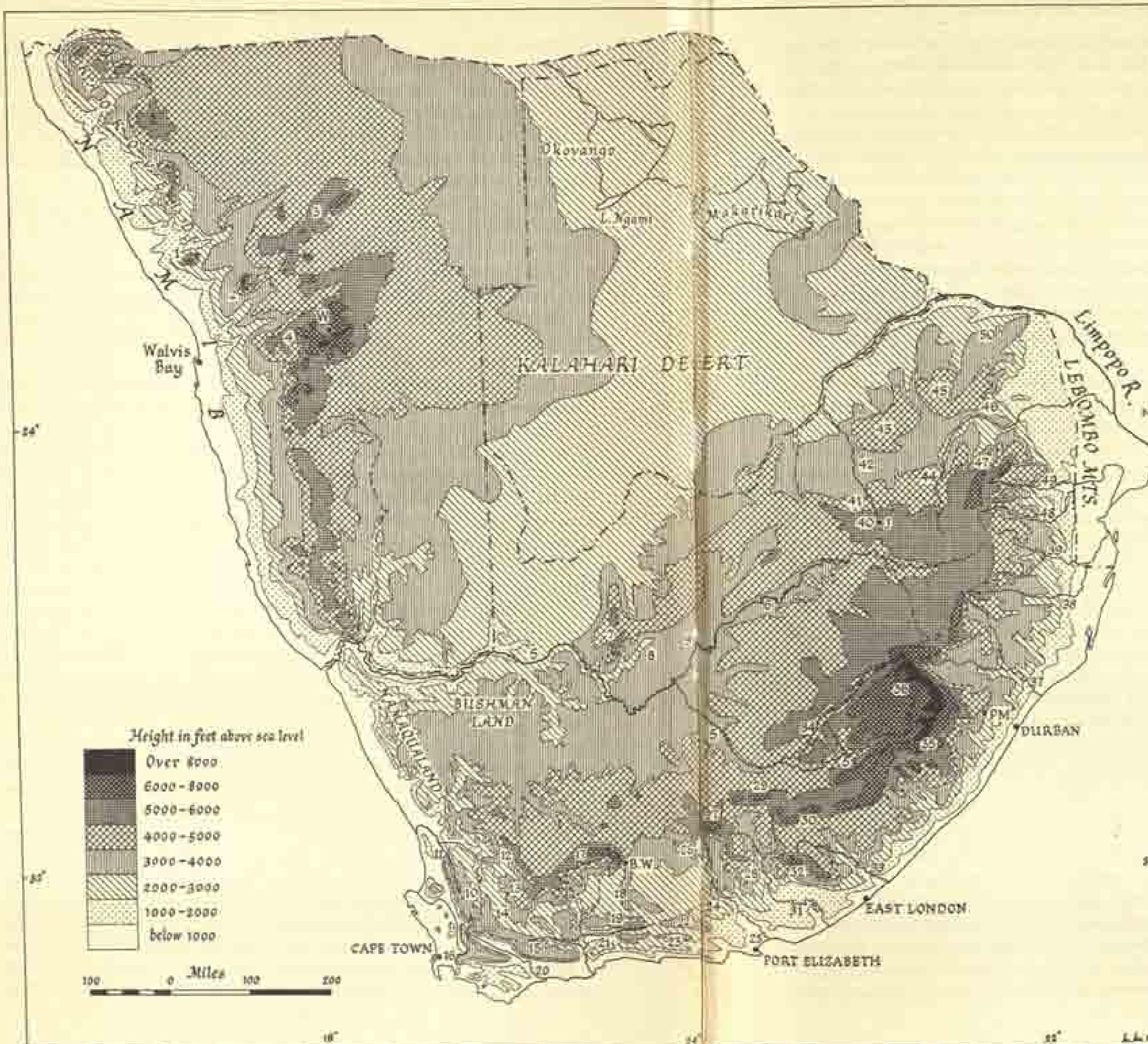
Along the Basutoland–Natal border the Great Escarpment separates the Gondwana surface of Basutoland, where it is surmounted by remnants of an older and higher erosion surface – probably the oldest in Southern Africa – from the African or Miocene surface of Natal (Fig. 10). Northwards it separates the latter from the Gondwana surface of the Highveld from which all trace of any earlier surface has disappeared. In both sections a foothill zone ascribed to a post-

Gondwana cycle and carved during the period of uplift associated with isostatic recovery in early Cretaceous times may connect the plateau with the coastal belt. Still farther north in the eastern Transvaal the Great Escarpment separates surfaces cut in more recent cycles. In the Cape the relationship of the Great Escarpment to erosion surfaces is complicated and obscured by the intervention of the Cape ranges between it and the coast. In South-West Africa the position repeats that of the north-eastern Transvaal.

The Great Escarpment may therefore be considered in four sections – (1) The Basutoland–Natal section where it is cut into Stormberg basalts and separates the Jurassic surface of Basutoland from the Miocene surface of Natal, (2) the Northern Natal–Transvaal section where it is cut into progressively older rocks and separates surfaces cut in progressive younger erosion cycles northwards, (3) the somewhat similar South-West Africa section, and (4) the Cape section where it is cut into Karoo rocks but its relationship to erosion surfaces is complicated by the presence of the Cape ranges.

Due to its mode of origin and to the nature of the rocks involved the Great Escarpment attains its most majestic form in the great wall of the Natal Drakensberg along the Basutoland border between Mont-aux-Sources in the north and Xalanga peak in the south (Plates 9–11). Here the African cycle attacking the repeatedly uplifted Gondwana and earlier surfaces has encountered the highly resistant Stormberg basalts, in places over 4,500 feet thick and overlying softer Karoo sandstones and shales, and has produced a particularly abrupt scarp. At its maximum development at Mont-aux-Sources the scarp face is fully 7,000 feet from foot to crest while even at Xalanga peak it is 2,500 feet. The highest parts of the Berg – Mont-aux-Sources, Cathkin Peak, Cathedral Peak, Champagne Castle, and Giants Castle – rise to more than 10,000 feet with the highest point so far determined trigomonetrically, Thabana-Ntlengana, south-west of Giants Castle reaching 11,425 feet. Throughout this section the Escarpment constitutes a formidable barrier to communications and indeed in one stretch of 160 miles between Oliviershoek (north of Mont-aux-Sources) and Qachas Nek (north of Matatiele) not a road crosses it.

North of the Natal Drakensberg the Escarpment is generally lower, for here it separates the Gondwana surface of the Highveld from the African surface of the coastal belt; remnants of older and higher surfaces are wanting and the Stormberg basalts are absent. The form and boldness of the Escarpment are related to the rocks into which it is cut. North of the Basutoland lava plateau the Karoo sandstone, in places protected by thin dolerite sills, give rise to well-marked but lower and less continuous escarpments than in the Natal Drakensberg. Along the Free State–Natal border the Escarpment, known as the Low Berg to distinguish it from the High Berg of the Basutoland–Natal border, is much broken by the headward erosion of streams draining to the Tugela and Buffalo rivers. Here there are numerous passes, many of which carry roads and the most important, the railways from Durban to the Orange Free State and to the Witwatersrand. Farther



KEY

MOUNTAINS

Asbestos Mts – 8
Bankeveld – 41, 47
Brandberg – 1
Bushveld Basin – 42
Cedarbergen – 10
Drakensberg – 35, 46
Erongo Mts – 2
Great Karoo – 18
Great Winterberg – 32
Groote R. Hts – 24
Hex R. Mts – 14
Hottentot Holland Mts – 16
Kaap Plateau – 9
Khomas Highlands – 4
Koedoes Mts – 13
Koudeveld Berg – 26
Kouga Mts – 22
Langebergen – 7, 15
Little Karoo – 21
Maluti Mts – 36
Nieuwveld Range – 17
Pietersburg Plateau – 45
Roggeveld Mts — 12
Sneeuwbergen – 27
Soutpansberge – 50
Stormberg – 30
Suurberg – 29
Tandjes Berg – 28
Tsitsikama Mts – 23
Waterberg – 3
Waterberg Plateau – 43
Witwatersrand – 40
Zwarte Bergen – 19

RIVERS

Breede R. – 20
Caledon R. – 34
Crocodile R. – 49
Great Fish R. – 31
Great Kei R. – 33
Komati R. – 48
Olifants R. – 11, 44
Orange R. – 5
Pongola R. – 38
Sundays R. – 25
Tugela R. – 37
Usutu R. – 39
Vaal R. – 6

B.W – Beaufort West
J – Johannesburg
PM. – Pietermaritzburg
W – Windhoek

Fig. 11. Relief.

north the Great Escarpment is strongly developed in the Transvaal Drakensberg between Carolina in the south and Wolkberg in the north where it is formed of tough westward-dipping Black Reef quartzites (see p. 7) overlying softer granite (Plate 11). Between Kaapsche Hoop and Graskop the Escarpment is in places a double feature for to the west of the Black Reef escarpment the quartzites and lavas of the Pretoria Series produce striking ridges. Mount Anderson reaching 7,498 feet and built of andesitic lavas of the latter series actually towers more than 3,000 feet above the summit of the Black Reef scarp. By contrast on the borders of the Transvaal and Swaziland and again in the north-eastern Transvaal, where the readily eroded Old Granite is exposed over a wide area, the Escarpment as a linear feature is altogether missing and only the gently sloping spurs between the river valleys mark the descent from the plateau to the marginal belt. The weak development of the Escarpment in this area is economically very important for it allows oceanic climatic influences to reach the plateau with favourable consequences for human activities.

In the southern Cape the strength of the Great Escarpment is closely related to the presence of intrusive dolerite sheets within the Karoo rocks. Generally speaking it forms a continuous wall and barrier to communications which is most formidable in the Sneeuwbergen, Nieuweveld and Roggeveld where thick sheets of dolerite capping Karoo sandstones and shales are responsible for abrupt scarp faces. The most important break is the sixty-mile gap north of Beaufort West (Fig. 11) where the weak development or absence of the dolerite sheets which form the Nieuweveld and Sneeuwberge, has allowed the Kariega and Salt river headwaters of the Groot river to cut wide valleys into the plateau. This gap is utilized by the main line railway from Cape Town to the Transvaal and the Rhodesias. Likewise in the south-eastern Cape where thick dolerite sheets are again lacking, the headstreams of the Great Fish river have eaten into and broken up the Suurberge, Kikvorschberge, and Agter Renosterberge thereby affording a routeway for the main line railway from Port Elizabeth to the interior.

In South West Africa the Great Escarpment is a well-developed bold feature where Nama quartzites and limestone overlying basal crystaliine rocks have been encountered between the Orange and Kuiseb rivers. Elsewhere, however, it is cut mainly into Archaean rocks mostly granites and gneisses and is not very well defined.

The Plateau Regions

Based on altitude and surface form the plateau is composed of two major sub-regions – the Kalahari basin and the peripheral highlands (Fig. 12).

The Kalahari Basin, for the most part lying between 2,000 and 4,000 feet above sea-level, is a vast sand-covered surface which is either without surface drainage or else drains to an interior basin. By contrast, the peripheral highlands generally exceed 4,000 feet in elevation and are composed of solid rocks, ranging in age from pre-Cambrian to Cretaceous, and drain to the oceans. In structure and

surface form they are complex but essentially comprise four major components – the Highlands of South West Africa, the Cape Middleveld, the South African Highveld, and the Transvaal Plateau Basin. In addition the Limpopo depression belongs more properly to the peripheral highlands than to either the Kalahari basin or the marginal belt.

The Highlands of South West Africa comprise an upland area of varied relief, where aridity is responsible for gaunt features whose individual form varies with the nature of the underlying rock. It is distinguished from the Cape Middleveld by reason of its higher altitude. The latter sub-region actually has a slightly lower altitude than the adjoining Kalahari basin from which it is distinguished by its exterior drainage and very different geology and surface features. The drainage is to the Orange river which trenches the plateau rim in order to reach the sea. The Cape Middleveld is underlain mainly by ancient rocks which in places are thinly covered with Karoo sediments and dolerite. For the most part it is a stony or rocky plain, in the north-west broken only by gaunt ridges, where resistant quartzites of Nama or Black Reef age outcrop, and in the east, where the Karoo cover remains, studded with dolerite capped tafel-kops (flat-topped mesas). The South African Highveld lying mainly between 4,000 and 6,000 feet above sea-level but including the Basutoland lava plateau with an elevation of between 8,000 and 11,000, is distinguished by the monotonously level nature of its surface form developed over Karoo and pre-Karoo rocks alike, and by the way in which, except in the north and south-west, it overlooks adjacent areas by sharp escarpments. The Transvaal Plateau basin is distinct from these sub-regions for, although containing extensive level surfaces which in the Waterberg and Pietersburg plateaux are comparable with those of the Highveld, it owes its special character to the structural features associated with the Bushveld Igneous Complex. To the north the Limpopo valley, lying at an altitude decreasing from 3,500 feet in the west to 800 feet at the Mozambique border and overlooked by the high escarpment of the Waterberg plateau, represents a downfaulted depression within the plateau surface. Underlain mainly by Old Granite it today comprises an exceedingly level plain broken only by isolated inselberge, which contrasts with the uplands of the Transvaal Plateau basin and the basin of the Kalahari alike.

The Marginal Lands

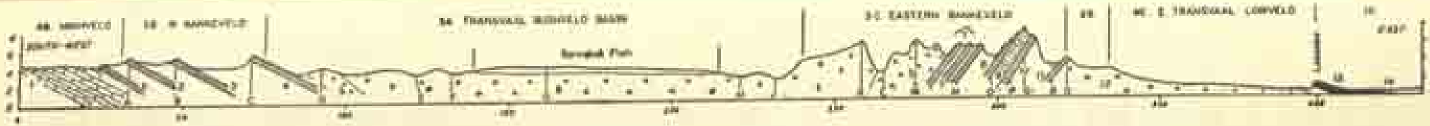
Structurally and geomorphologically the lands below the Escarpment consist of three major units – the Eastern Plateau Slopes, the Southern Marginal Belt and the Western Plateau Slopes. The first mentioned, fashioned by the headward erosion of the rivers draining to the Indian ocean, is characterized by great spurs, the remnants of the plateau surface, rising abruptly above extensive level basins or flats which have been opened out along the river valleys. Contrasting with this sub-region is the Southern Marginal Belt which owes its characteristic features of long parallel ranges towering over broad longitudinal valleys to its folded

structure and to the processes of adjustment to structure which have etched out the difference between the resistant sandstones and soft shales. Included within this belt, however, are the erosional basins of the Great and Little Karoo and

Fig. 12. The physiographic regions.

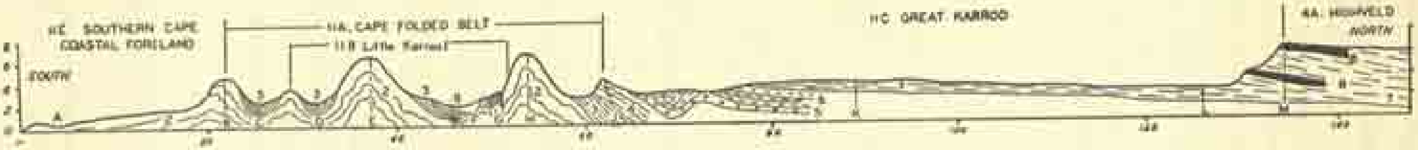
(Regional boundaries after J. H. Wellington except in northern Natal and Zululand.)

1. *The Kalahari Basin:* 1a. The Southern Kalahari; 1b. The Northern Kalahari. 2. *The Highlands of South West Africa:* 2a. The Otavi-Ovashimba Highlands; 2b. The Damaraland Plateau; 2c. The Khomas Highlands; 2d. The Namaqualand Highlands. 3. *The Cape Middleveld:* 3a. Eastern Namaqualand; 3b. The Little Namaqualand-Bushmanland Plain; 3c. The Orange River Gorge Tract; 3d. The Southern Cape Middleveld. 4. *The South African Highveld:* 4a. The Highveld (Karoo Surface); 4b. The Highveld (pre-Karoo Surface); 4c. The Kaap Plateau; 4d. The Basuto Highlands. 5. *The Transvaal Plateau Basin:* 5a. The Bushveld Basin; 5b. The Western Bankeveld; 5c. The Eastern Bankeveld; 5d. The Waterberg Plateau; 5e. The Soutpansberge; 5f. The Pietersburg Plain. 6. *The Limpopo Depression.* 7. *The Eastern Plateau Slopes:* 7a. The Uplands of the Eastern Cape, Natal and Western Swaziland; 7b. The Lowveld of the Eastern Transvaal and Eastern Swaziland; 7c. The Coastal Belt of Natal and the Transkei. 8. *The Coastal Plain of Zululand and Mozambique.* 9. *The Southern Cape:* 9a. The Cape Folded Belt; 9b. The Little Karoo; 9c. The Great Karoo; 9d. The Western Coastal Foreland; 9e. The Southern Coastal Foreland. 10. *The Western Plateau Slopes:* 10a. The Southern Namib; 10b. The Middle Namib; 10c. The Northern Namib; 10d. The Uplands of North-Western South West Africa.



Section 1

Section 2



Section 3

Section 1
1, Dolomite. 2, Timeball Hill Quartzite. 3, Daspoort Quartzite. 4, Magaliesberg Quartzite. 5, Norite. 6, Bushveld Granite. 7, Witrand (Magaliesberg) Quartzites. 8, Tunnel and Dwaal Heuvel (Daspoort) Quartzites. 9, Nooitedacht (Timeball Hill) Quartzites. 10, Dolomite. 11, Black Reef Quartzite. 12, Old Granite. 13, Karroo Rhyolite. 14, Cretaceous and Tertiary Marine Beds. A, Timeball Range Hill. B, Daspoort Range. C, Magaliesberg. D, Swartkoppies Ridge. E, Crocodile R. F, Pienaars R. G, Warmbaths. H, Elands R. J, Olifants R. K, Sekukuni Escarpment. L, Steelpoort R. M, Lulo Mountains. N, Steenkamps Berge. O, Lydenburg. P, Paardeplaats Ridges. Q, Mount Anderson. R, Sabie. S, Black Reef Escarpment. T, Die Berg.

Section 2
1–5, Karroo System. 1, Drakensberg Lava. 2, Stormberg Sediments. 3, Beaufort Series. 4, Ecca Series. 5, Dwyka Series. 6, Old Granite. 7, Table Mountain Sandstone. 8, Ventersdorp Lava. 9, Campbell Rand Limestones and Lower Griquatown Beds. 10, Matsap Quartzites. 11, Kalahari Sand. A, Skurweberge. B, Langeberge. C, Gamagara Ridge. D, Asbestos Mountains. E, Campbell Rand. F, Dry Harts R. G, Vaal R. H, Brandfort. J, Koranna Berg. K, Caledon R. L, Maluti Mountains. M, Madibamatso R. N, Matsoku R. O, Khubedu R. P, Giant's Castle. Q, Mooi R. R, Stanger.

Section 3
1, Cango Beds. 2, Table Mountain Sandstone. 3, Bokkeveld Series. 4, Witteberg Series. 5, Dwyka Series. 6, Ecca Series. 7, Beaufort Series. 8, Dolerite. 9, Uitenhage Series. A, Knysna. B, Outeniqua Mountains. C, Long Kloof. D, Kamanassie R. E, Kamanassie Mountains. F, Olifants R. G, Cango. H, Groot Swartberge. J, Witteberge. K, Dwaalberg. L, Beaufort West. M, Nieuwveld Escarpment.

In all sections, distances are shown in miles and altitudes in thousands of feet.

Fig. 13. Sections across certain physiographic regions.
(After J. H. Wellington, courtesy *South African Geographical Journal*.)

the lowlands of the coastal forelands (Fig. 13). Different again are the Western Plateau Slopes, which have evolved under conditions of great aridity, are much narrower than those in the east and are characterized by bare rock surfaces near the Escarpment giving way to sand surfaces along the coast.

Within each of the physiographic regions thus recognized, differences of structure and rock formation have been so projected into the surface features as to produce distinct sub-regions. Often too, they are transmitted into differing soils and vegetation and are responsible for differing opportunities for human occupance and endeavour. Since one of the aims of this book is to examine economic activities against the background of the physical environment, the features of these sub-regions will be considered in the regional chapters.

BIBLIOGRAPHY

1. A. L. du TOIT. *Geology of South Africa*, 3rd edition, edited and prepared by S. H. Haughton, Edinburgh. 1954.
2. L. C. KING. *South African Scenery*, 2nd edition. Oliver and Boyd, Edinburgh. 1951.
3. J. H. WELLINGTON. 'The pre-Karoo peneplain in the south-central Transvaal.' *S.A.J.Sc.*, Vol. XXXIII, 1937.
4. J. H. WELLINGTON. 'Stages in river superimposition in the southern Transvaal.' *S.A.J.Sc.*, Vol. XXVII, 1940.
5. F. DIXEY. 'Notes on the erosion cycle of the southern Transvaal.' *S.A.G.J.*, Vol. XXIV, 1942.
6. L. C. KING. 'Pediplanation and Isostasy. An example from South Africa.' *Q.J.G.S.*, Vol. CXI, 1956, pp. 353–9.
7. L. C. KING. 'Geomorphology of the Natal Drakensberg.' *T.G.S.S.A.*, Vol. XLVII, 1944, pp. 255–82.
8. J. H. WELLINGTON. 'A physiographic regional classification of South Africa.' *S.A.G.J.*, Vol. XXVIII, 1946, pp. 64–86.
9. A. L. HALL. 'The Barberton Mountain Land.' *S.A.G.J.*, Vol. IV (1920–1).
10. A. L. HALL. 'The geology of the Barberton gold mining district.' *Union of S.A. Geol. Surv.*, Mem. No. 9, Pretoria. 1918.
11. A. L. HALL. 'The Bushveld Igneous Complex of the Central Transvaal.' *Union of S.A. Geol. Surv.*, Mem. No. 28, Pretoria. 1932.
12. Symposium sur les séries de Gondwana. XIXe Congrès Geologique International, Alger. 1952.
13. A. L. du TOIT. 'Carboniferous glaciation of South Africa.' *T.G.S.S.A.*, Vol. XXIV, 1921.
14. F. DIXEY. 'Some observations on the physiographical development of central and southern Africa.' *T.G.S.S.A.*, Vol. XLI, 1938.

15. F. DIXEY. 'Erosion cycles in Central and South Africa.' *T.G.S.S.A.*, Vol. XLV, 1942.
16. L. C. KING. 'Landscape study in Southern Africa.' *T.G.S.S.A.*, Vol. L, 1947.
17. L. C. KING. 'On the ages of African land surfaces.' *Q.J.G.S.*, Vol. CIV, 1948.
18. J. H. WELLINGTON. 'The middle course of the Orange river.' *S.A.G.J.*, Vol. XVI, 1933.
19. A. W. ROGERS. 'Geological survey and its aims; and a discussion on the origins of the Great Escarpment.' *T.G.S.S.A.*, Vol. XIII, 1920.
20. A. L. HALL. 'The Transvaal Drakensberg.' *S.A.G.J.*, Vol. VIII, 1925.
21. A. W. ROGERS. 'The build of the Kalahari.' *S.A.G.J.*, Vol. XVII, 1934.
22. A. W. ROGERS. 'The "solid" geology of the Kalahari.' *J.R.S.S.A.*, Vol. XXIII, 1936.
23. A. D. LEWIS. 'Sand dunes of the Kalahari.' *S.A.G.J.*, Vol. XIX, 1936.
24. T. W. GEVERS. 'The geology of the Windhoek district in South West Africa.' *T.G.S.S.A.*, Vol. XXVII, 1934.
25. J. H. WELLINGTON. 'The boundaries of the Highveld.' *S.A.G.J.*, Vol. XXVI, 1944.
26. J. H. WELLINGTON. 'The Vaal-Limpopo watershed.' *S.A.G.J.*, Vol. XII, 1929.
27. J. H. WELLINGTON. 'The topographical features of the Witwatersrand.' *S.A.G.J.*, Vol. VII, 1924.
28. A. L. du TOIT. 'Crustal movements in South Africa.' *S.A.G.J.*, Vol. XVI, 1933.
29. J. H. WELLINGTON. 'Some physical factors affecting the economic development of the Eastern Cape Province.' *S.A.G.J.*, Vol. XI, 1928.
30. J. H. WELLINGTON. 'The surface features of Natal.' *S.A.G.J.*, Vol. XV, 1932.

2

Weather and Climate

At any moment the actual weather experienced over any area is determined by the properties and behaviour of the air mass or masses over it, while the sequence is governed by the interaction of air masses of differing temperature and humidity conditions. The climate is the result of the frequency with which these air masses become established over an area or interact with one another along lines of discontinuity over a period of years. These statements are true of temperate and tropical lands alike, the differences which distinguish the climates of the two zones being due to the differing properties of the air masses concerned, while the variations within the zone result from the persistent or transitory establishment of the several air masses affecting them. In Southern Africa, however, the relationship between the air masses and consequently the behaviour of the latter are complicated by the fact that the greater part of the country consists of a high plateau with an average elevation of 4,000 feet abruptly delimited by the Great Escarpment below which a belt of marginal low lands extends to the coast. As a result there is a marked discontinuity between the circulations over the two major physiographic regions (Fig. 14). For this reason, a preliminary picture of the distribution of pressure and of the direction and speed of air movement is best obtained by considering the conditions at a given height above both plateau and marginal belt.

Recent work[1, 2] has revealed that at a height of 2,000 metres which is a little above that of the plateau surface the mean pressures for both July and January indicate the presence of a weak anticyclone over the eastern half of the country (Fig. 15). This no doubt results from the fact that the temperatures, determined by solar control, elevation, and distance from the sea, are low for the latitude, particularly over the eastern part of the plateau, where at an altitude of about 5,000 feet, the means for the winter months lie between 45° and 50° F. Largely as a result of differences in the temperature distribution the anticyclone moves northwards and centres over the Limpopo in winter, thereby bringing the westerlies over the southern Cape, and southwards in summer, when its centre lies over Mont-aux-Sources and easterly and north-easterly winds prevail over the Transvaal and northern Natal, bringing in moist air from the Indian ocean. The move-

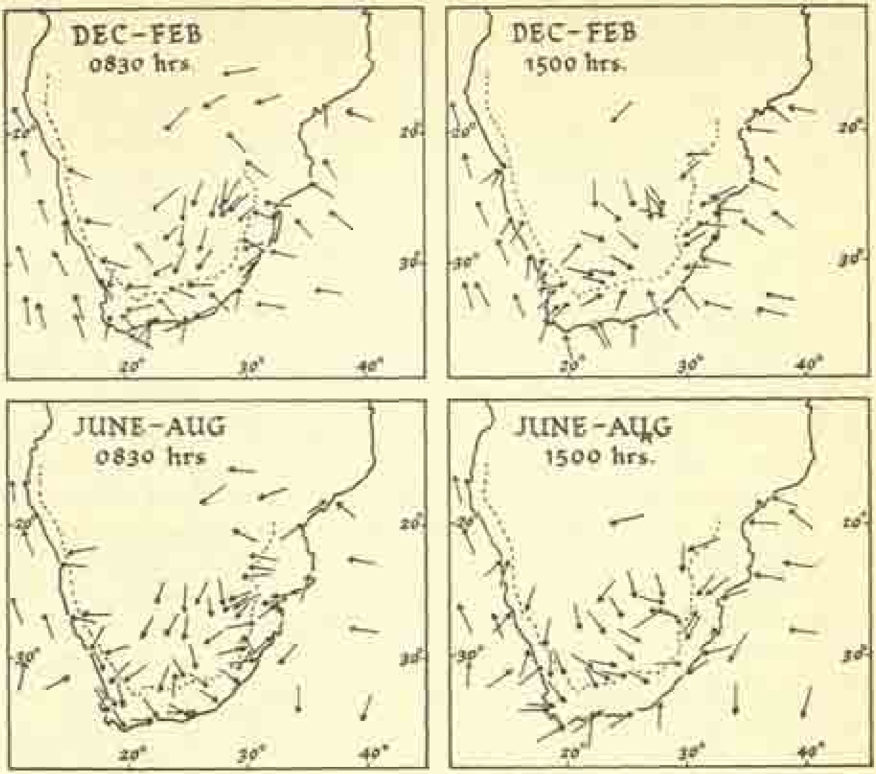


Fig. 14. Resultant directions of surface winds in summer (above) **and winter** (below).

The broken line indicates the position of the Great Escarpment. (After S. P. Jackson, courtesy *South African Geographical Journal.*)

ments of the anticyclone are thus responsible for the occurrence of rainfall during winter in the south-western and southern Cape and during summer over the eastern and greater part of the country, and also for its well-marked seasonal distribution. Over the western half of the country winds tend to be northerly or north-westerly in both seasons, circulating outwards from the high pressure centre; their continental origin condemns the interior lands to aridity.

Mean figures give only the average picture and the actual weather experienced depends on the existing synoptic situation.[8] The South African Meteorological Office has recognized six characteristic synoptic situations, each associated with distinctive weather conditions. These weather types, as they have been termed, are shown in Figs. 16–23. Conditions, however, vary little from day to day. Over the plateau in winter anticyclonic conditions may persist for weeks on end and are broken only by occasional tongues of low pressure from the south or south-east as lows pass up the coast. In summer conditions are more variable and

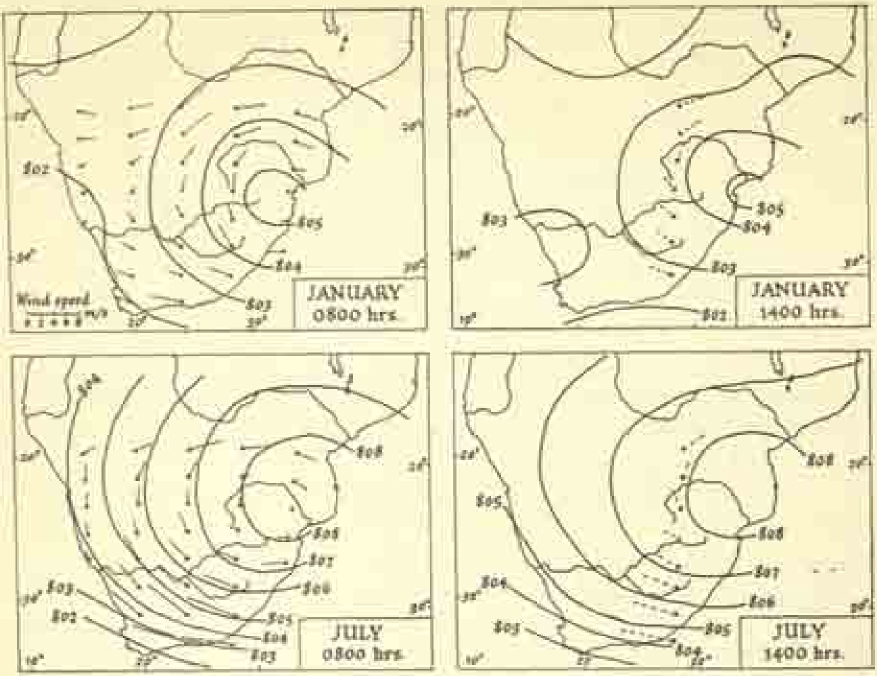


Fig. 15. Isobars of mean pressure over Southern Africa at 2,000 g.p.m.
The arrows on the left-hand maps show the direction and velocity of the resultant winds at that level obtained from pilot balloon observations; those on the right-hand maps show geostropic winds calculated from the isobars. (After S. P. Jackson, courtesy *South African Geographical Journal*.)

the weakening of the anticyclone permits the entry of moist air from the Indian ocean. Below the Great Escarpment pressure conditions are subject to greater and more frequent variation as highs and lows succeed one another in their passage round the coasts. Sometimes these passing pressure systems extend their influence over the plateau.

The discontinuity between the circulations over the plateau and the marginal lands is fundamental in any consideration of weather in Southern Africa. It is most marked in summer when the winds are northerly or north-easterly in the morning backing to north-westerly and westerly in the afternoon over the plateau, while over the country between the Escarpment and the coast, they blow inwards as if circulating around an area of low pressure over the plateau. In winter the circulation over the plateau is similar, but the discontinuity is less marked and north-westerly winds may be experienced in the coastal lands. An examination of the winds near the surface and in the upper air,[4] suggests that this discontinuity may be associated with the fact that the plateau surface lies near the boundary between the generally westerly upper air circulation and the easterly surface

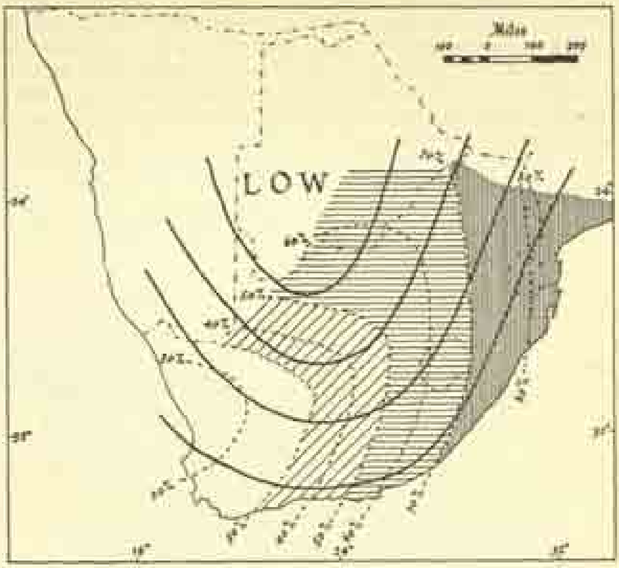


Fig. 16a. Weather type A (summer).

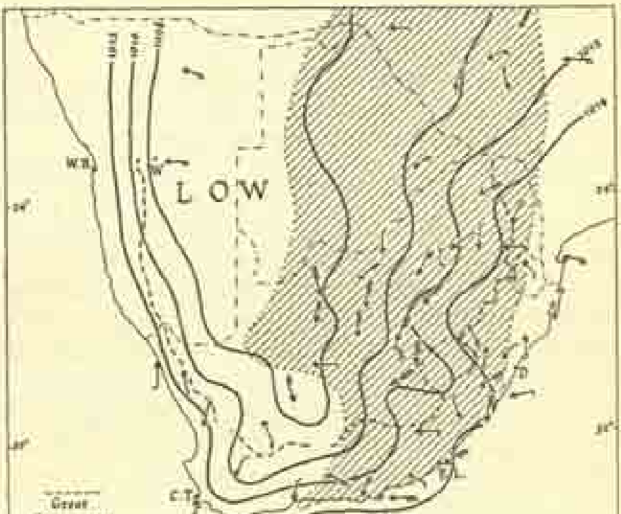


Fig. 16b. Synoptic chart. 2 Dec. 1938.

Rain falls in the shaded area on more than 30 per cent. of the occasions when this weather type (Fig. 16a) occurs. The synoptic chart (Fig. 16b) shows an actual occurrence of this type when rain was widespread over the eastern half of the country. Isobars show pressures reduced to sea-level; wind force is according to the Beaufort scale. (These and the following types and examples are taken from *Atmospheric Pressure and Weather Charts* by T. E. W. Schumann, Union Meteorological Office, Pretoria, 1941.)

The Summer Weather Types

Type A (Fig. 16) represents the characteristic summer conditions, although occurring on an average of only 24 days per year. Very high temperatures over the interior are associated with the development of a continental low. There is a general inflow of moist air from the Indian ocean. The high surface temperatures, steep lapse rates and high humidity are conducive to the development of the thunderstorms in the late afternoon which characterize this weather type. Thunderstorm rains usually occur over the greater part of the eastern half of the country.

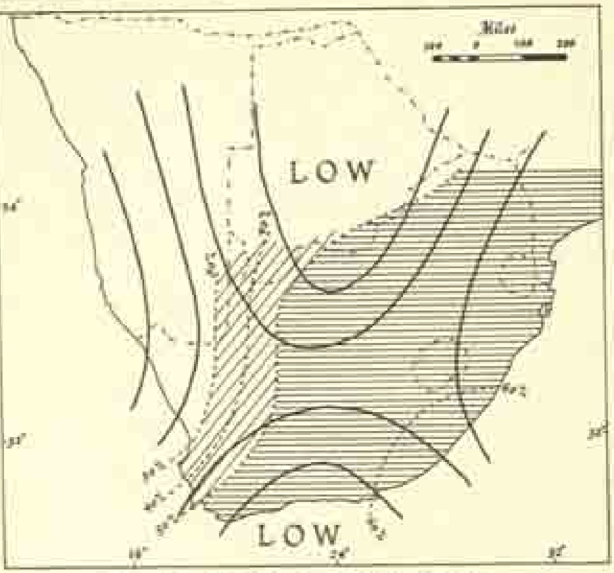


Fig. 17a. Weather type B_1 (summer).

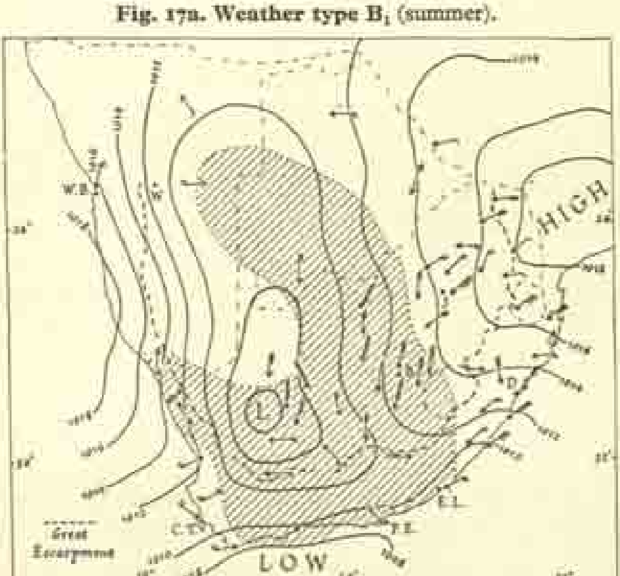


Fig. 17b. Synoptic chart. 3 Feb. 1940.

Type B_1 (Fig. 17), which develops when the tropical low over the interior links up with the temperate low to the south, occurs slightly more frequently than Type A, notably towards the end of summer. The high to the north-east results in an inflow of moist air far into the interior, so that the area east of the tropical low experiences cloudy weather conditions leading to thunderstorms in the late afternoon. The area north-west and west of the temperate low is characterized by cloudy unsettled weather which spreads eastwards with the passage of the low. The area east of the temperate low, however, experiences very hot, hazy conditions as the northerly winds bring hot continental air over the coastal belt and berg winds develop. Whereas in Type A the tropical low is stationary over the interior, in Type B_1 it moves in the same direction as the temperate or complementary low, the synoptic situation changing to Type B_2.

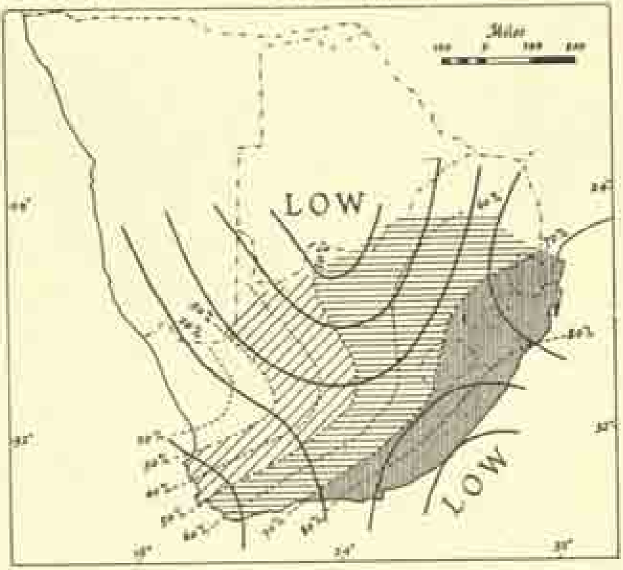
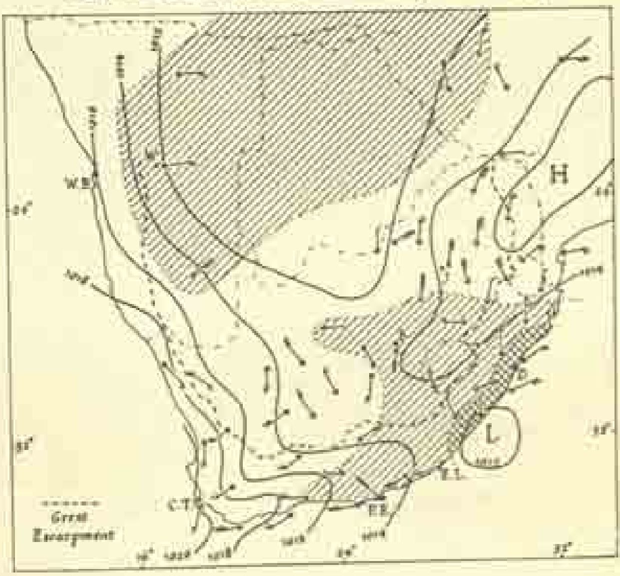


Fig. 18a (above) Weather type B_1 (summer).
Fig. 18b (below) Synoptic chart. 30 Nov. 1937.



Type B_1 (Fig. 18) when the temperate low has reached the south-east coast and is separated from the tropical low by highs extending from the north-east and south-west. With such a pressure distribution in summer the south-east of the country receives rainfall on 70 per cent. and the coastal belt on 80 per cent. of the occurrences. This weather type occurs more frequently than any other, on an average of 50 days during the summer months and 62 days during the year. When the high from the west moves eastwards and links up with the eastern high the weather type changes to Type C_4.

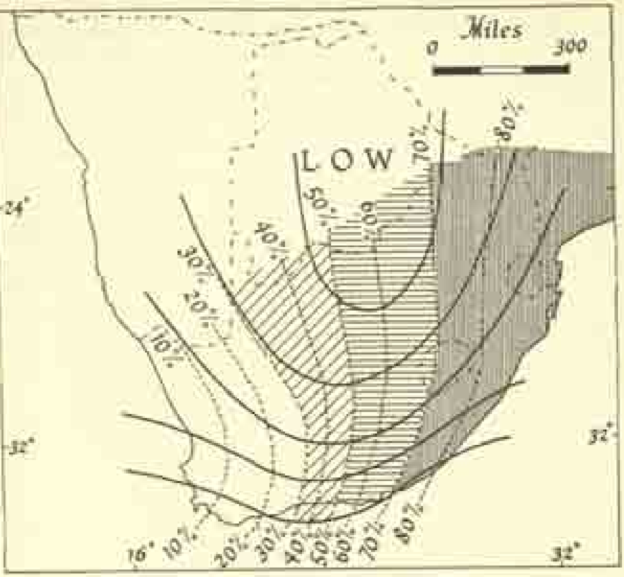


Fig. 19a. Weather type C_1 (summer).

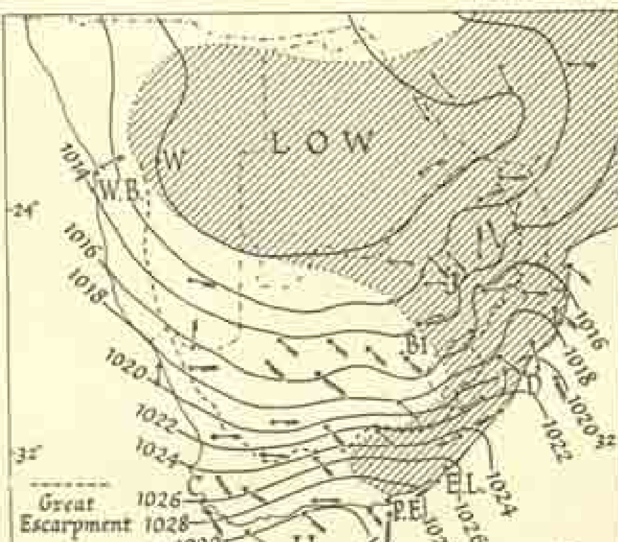


Fig. 19b. Synoptic chart. 1 Dec. 1937.

Type C. The high advancing from the west is associated with an air mass which, originating over the South Atlantic ocean, is cooler and heavier than the continental air. When this cold air mass reaches the coast of the south-west Cape the obstruction presented by the Cape mountains and the plateau edge diverts the main flow eastwards along the coast. As the high moves around the coast its anti-clockwise circulation causes the banking up of air against the Escarpment so that the isobars take the form of a wedge extending northwards against the wall of the Drakensberg. At the same time as the originally cold air mass passes round the coast its lower layers become warm and humid as a result of

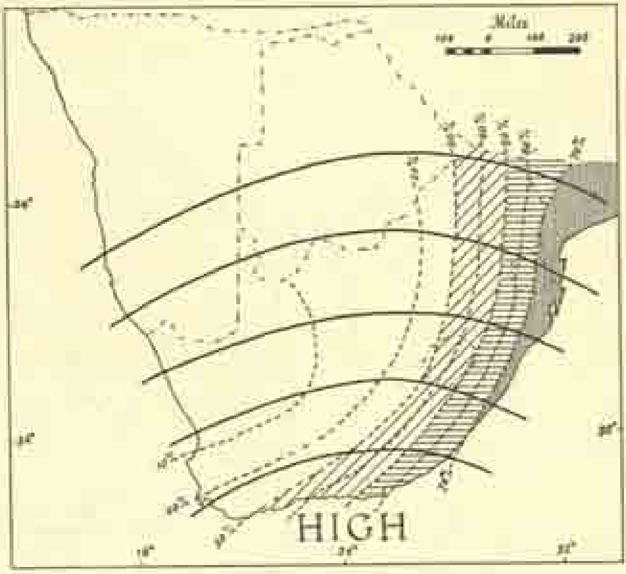


Fig. 20a. Weather type D_1 (winter).

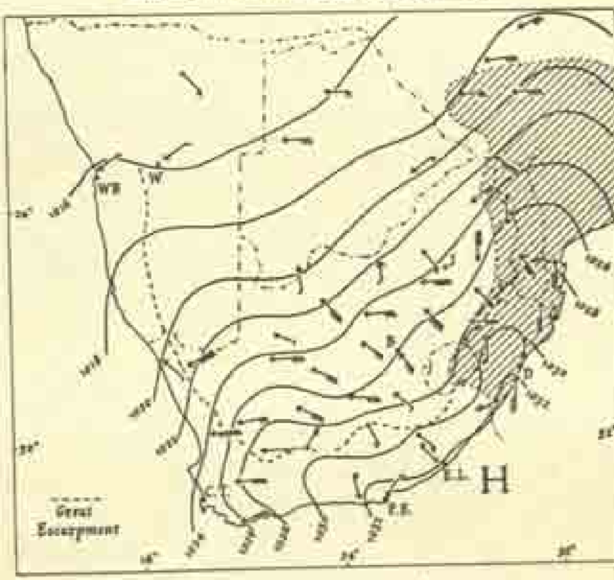


Fig. 20b. Synoptic chart. 27 Aug. 1939.

contact with the warm ocean washed by the Agulhas current. The air mass thus becomes unstable. With the high on the south-east or east coast, *Type* G_2, (Fig. 19), and a low over the interior there is an enormous inflow of humid air from the Indian ocean to the land. At the same time near the Drakensberg Escarpment, where the northerly winds from the plateau blow against the southerly winds in the wedge of high pressure, there is marked frontal activity. These conditions are associated with widespread general rains over the eastern half of Southern Africa extending into the north-east Cape and sometimes

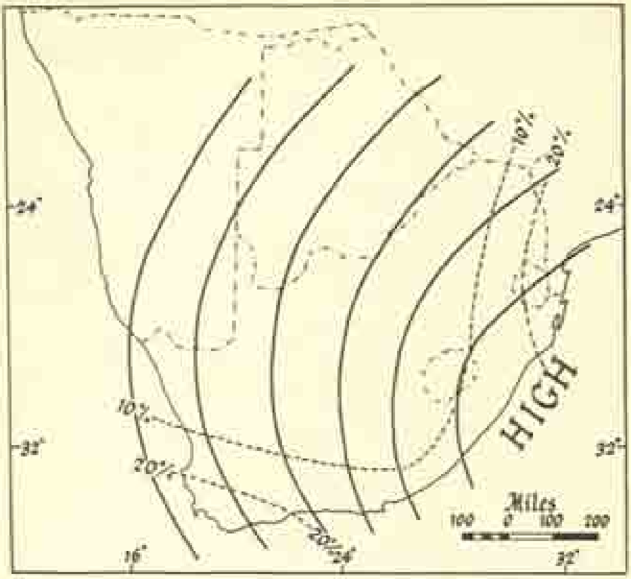


Fig. 21a. Weather type D_1 (winter).

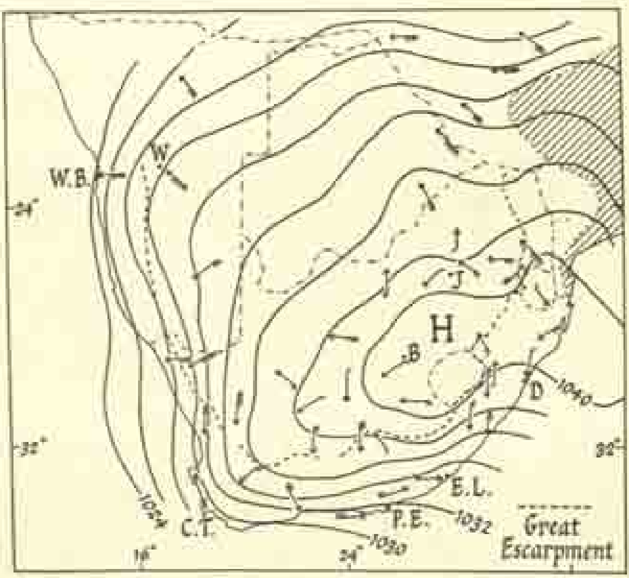


Fig. 21b. Synoptic chart. 16 July 1939.

even eastern Bechuanaland. The heaviest rains are experienced in the vicinity of the Escarpment being associated with frontal activity. As the high moves eastwards and pressure falls in the west strong south-east winds blow in the south-western Cape. This has occasioned the belief that the northern provinces get rain when the south-easters are strong in the Cape. As the high moves away the tropical low extends southwards again and there is a return to Type B_2 or Type B_1 weather.

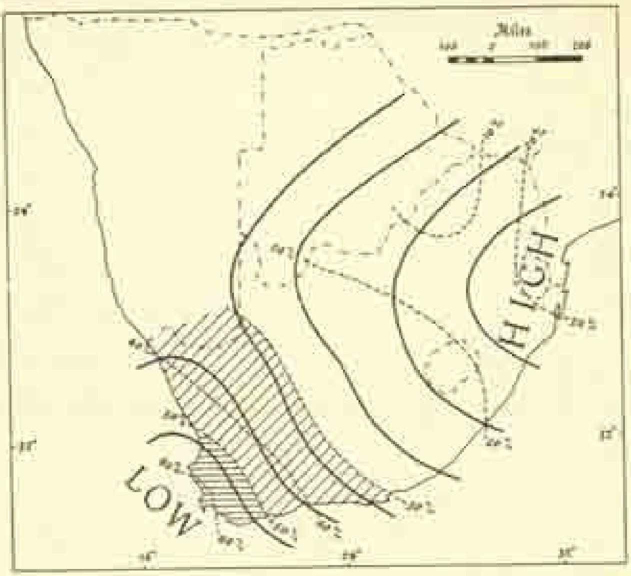


Fig. 22a. Weather type E_1 (winter).

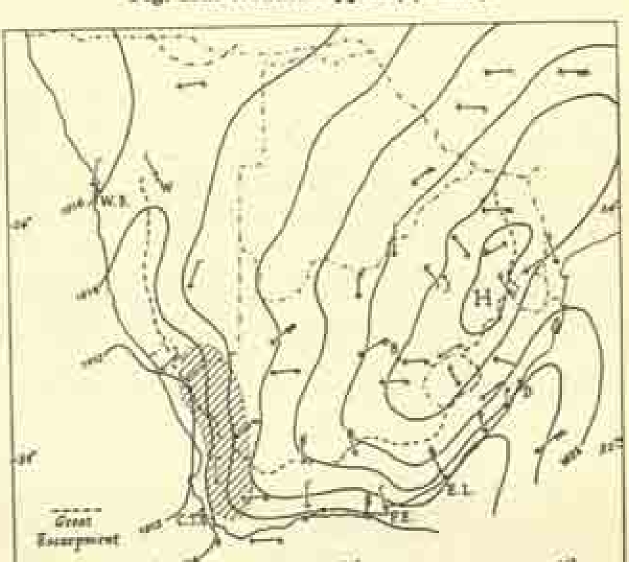


Fig. 22b. Synoptic chart. 21 July 1937.

The Winter Weather Types

Type D occurs in winter when the high-pressure belt lies approximately along latitude 30° S. Usually the winter plateau high is associated with the establishment of the 'Superior' air mass over the country and the weather is characterized by warm sunny days and clear cold nights with very little air movement (Type D_2, Fig. 20). Sometimes, however, travelling highs, originating over the South Atlantic and moving eastwards, occur in winter. These are usually deflected by the Great Escarpment so that they are

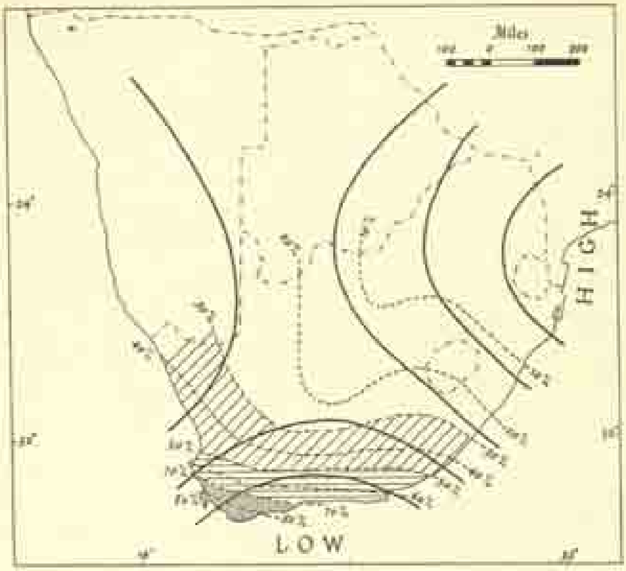


Fig. 23a. Weather type E_1 (winter).

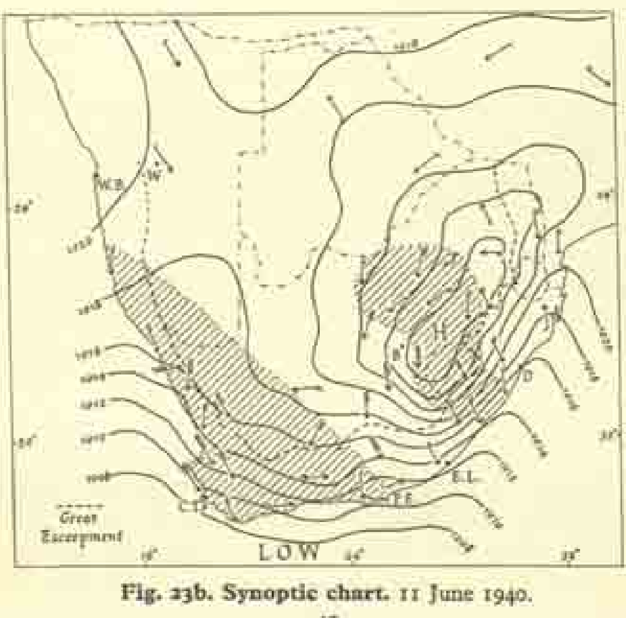


Fig. 23b. Synoptic chart. 11 June 1940.

confined to the southern coastal zone, leaving the anticyclonic conditions of the plateau undisturbed. As in weather Type C_2 the originally cold air mass becomes warmed in its lower layers during its passage round the coast; and when it reaches the east coast (Type D_2, Fig. 21) the northerly winds outblowing from the high cause an inflow of warm humid air from the Indian ocean to the land which results in winter rains over the eastern half of the country. When, however, the Atlantic high is strongly developed and the air mass is particularly cold and deep, as in the rear of a depression in the westerly wind belt, the system may penetrate the plateau. The passage of the lower layers of the air mass is obstructed by the Great Escarpment but the upper colder layers move over the plateau, carrying the 'polar' conditions associated with 'cold snaps' to the interior.

Type E. When the winter anticyclone is established over the plateau there is an outflow of air over the coastal belt; along the west coast this is associated with berg winds and very high temperatures, which in turn cause the development of a low (Type E_1, Fig. 22). This low unites with the circumpolar low to form an inverted 'V' shaped depression which moves eastwards along the south coast (Type E_2, Fig. 23), bringing the unsettled weather, strong north-westerly winds and rainfall associated with depressions, to each part of the coast in turn.

Type F is really a combination of Types B and E, which are summer and winter types respectively. Obtaining when there is a high over the eastern half of the country and lows over the interior and the south-western Cape this weather type occurs mainly in autumn and early summer when it may be associated with orographic drizzle along the Eastern Escarpment and thundery conditions, but rarely rain, over the interior.

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circulation. Turbulence over the heated surface tends to break down the shallow easterly current over the plateau, and bring the area under the influence of the upper air circulation. Below the Escarpment, however, the surface winds usually conform to the winds in the free air over the sea, and land and sea breezes are generally experienced on the coast. As a rule the winds prevailing in the coastal lowlands do not reach the plateau but occasionally in winter, cold southerly winds sweep over the Escarpment and across the plateau. Rather more frequently, winds from the plateau descend to the coastal belt in the form of hot berg winds.

The general circulations over the plateau and marginal lands of Southern Africa exert an important influence over the interaction of the various air masses affecting the country (Fig. 24). These are seven in number[8] and each owes its peculiar properties to its place and mode of origin. They may be grouped as follows:

(*a*) Tropical Continental air and Superior air which have subsided from high altitudes within the anticyclones of the sub-tropical high-pressure belt.
(*b*) Sub-Tropical Maritime air masses from the Atlantic and Indian oceans.
(*c*) Polar and Sub-Polar air masses from the Antarctic.
(*d*) Equatorial air mass.

The Superior air is brought to the plateau by the north-westerly winds in winter; it is warm and exceedingly dry, and gives rise to warm, dry, sunny days with temperatures rising above 60°–70° F. by midday, followed by cold clear nights during which terrestrial radiation is active, temperatures fall rapidly,

frequently to below freezing point,* and mist accumulates in the valleys and basins. The Tropical Continental air mass is brought by the north-easterly and northerly winds in summer. Although it originates in the sub-tropical high-pressure belt, it becomes modified during its passage over the hot humid coastal

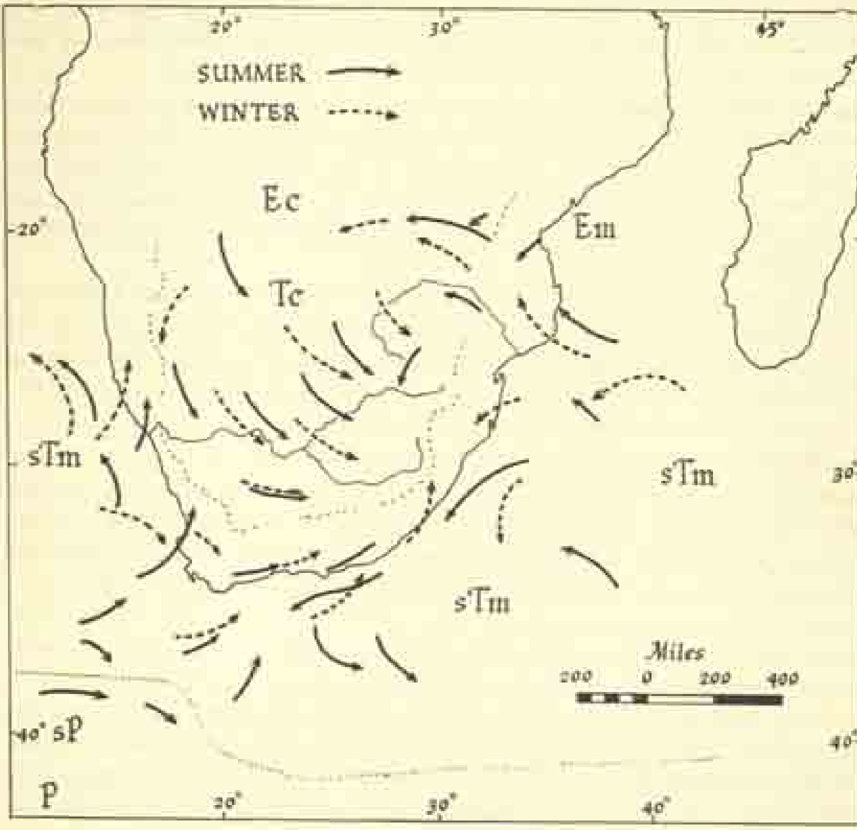


Fig. 24. Air Masses.

Tc, Tropical Continental. sTm, Sub-Tropical Maritime. sP, Sub-Polar. P, Polar. Ec, Equatorial Continental. Em. Equatorial Maritime. (After S. P. Jackson, courtesy *South African Geographical Journal*.)

lands and its subsequent uplift over the plateau and is generally warm and moist; it gives rise to conditions conducive to the development of thunderstorms. The Equatorial air mass which occasionally reaches the plateau in summer is warm and humid and brings general rains. The Sub-Tropical Maritime air masses control the weather in the coastal regions for most of the year. Both originate over

* The lowest temperature recorded is 5·6° F. at Carolina in July 1926. Minima of 9° F. have been experienced at a number of stations.

warm oceans, but whereas that from the Indian ocean passes over the warm southward-flowing Agulhas current with a mean surface temperature between 68° and 78° F.,* in order to reach the eastern marginal lands, that from the Atlantic has to cross the cool northward-flowing Benguela current with a mean surface temperature around 60° F. in order to reach the coast of South West Africa. The air mass from the Indian ocean is, therefore, warmer than that from the Atlantic; this is reflected in the generally higher temperatures along the east coast. As will be seen later, the difference helps to explain also the prevalence of fog at and off the coast in the west, whereas the east coast is generally clear, although mist and drizzle are experienced in the foothills below the Escarpment. The cold air masses from the Antarctic affect the coastal regions in winter and occasionally, when sufficiently deep, penetrate to the plateau where they are responsible for severe cold spells; they are responsible also for the snowfall on the marginal mountains.

Over the plateau conditions are generally stable and the weather experienced is determined largely by the properties of the Superior air in winter and the Tropical Continental air in summer. Conditions are more variable in the marginal belt where interaction between air masses of differing temperature and humidity conditions is frequent and is responsible for more changeable weather.

Frontal activity is most frequent in the south-western Cape Province where depressions in the westerly wind belt bring rainfall during the winter months (Fig. 23). These appear to form in the middle South Atlantic along a semi-permanent line of discontinuity between Sub-Tropical air, probably from the belt of high pressure, and cool Sub-Polar air, the former generally having a temperature between 55° and 65° F. and the latter below 60° F. These depressions are essentially similar to those in northern latitudes,[6] but the fronts and especially the warm fronts are less well defined. With the approach of one of these depressions the wind backs from south-east to north-east and north-west, when the arrival of the warm sector is heralded by stratiform cloud, drizzle, fog and rain, but the temperature falls instead of rises, the clouds which mark the passage of a warm front in northern latitudes are rarely present, while rain seldom occurs ahead of the warm front; this is probably due to the fact that to the north-west of Cape Town the Sub-Tropical air has moved over a stretch of ocean which, as a result of the upwelling of cold water originating in the Antarctic, is cool. The cold fronts are usually more clearly defined; the wind backs sharply to west and south-west and the Sub-Tropical air is replaced by colder and less stable air from the Antarctic; the passage of the cold front may be marked by a sudden squall while it is usually accompanied by a rapid fall in temperature, the development of broken cumulus clouds and short heavy showers separated by brighter intervals. The depression is usually followed by an anticyclone, and as this advances the weather clears and the wind backs steadily to south-east. As these depressions

* The temperature decreases from north to south, and is a little higher in summer than in winter.

move eastwards they bring rain to the various sections of the southern coastal belt in turn.

When the Sub-Polar air mass is exceptionally cold and moist it is particularly unstable and brings very cold weather, characterized by cumulo-nimbus clouds, heavy instability rains, hail and sometimes snow to the mountains and even the low-lying areas of the coastal belt, while if it is sufficiently deep it may reach the plateau, where spells of very severe weather are experienced.[7] These southerly winds sweep across the surface as the cold unstable air thrusts a wedge beneath the pre-existing warmer dry air which may be lifted sufficiently to produce some cloud, while snow may fall from the cold air itself on the Eastern Escarpment. Such a polar outbreak is followed, as a rule, by an anticyclone advancing from the west, which brings warm dry and stable air to replace the cold air. However, owing to the exceptionally dry nature of the new air mass, the temperatures near the ground, already low, frequently fall still further, so that the lowest temperatures are actually experienced after the cold air has gone. Soon, however, the replacement of the cold air by the warm dry air brings a return to normal conditions.

The discontinuity between the circulations over the plateau and the marginal lands has already been stressed. With this is associated what may be called a semi-permanent front lying close to the Escarpment. The coastal areas of the south and south-east receive rainfall in summer as well as in winter; it is likely that the summer rains are caused by the ascent of the warm damp air over the cooler air mass lying over the coastal lands. This is a more likely explanation than the suggestion that they are brought by the south-east trade winds which are blowing from a cooler to a warmer region. These winds may bring in a cool air mass over the marginal lands, but the actual rainfall appears to result from frontal activity.

Over the greater part of the country the rainfall occurs during thunderstorms in summer. It is considered to result from active convection, caused by intense surface heating, in a moist air mass which has been brought in from over the Indian ocean. (See Fig. 16.) But the storms are local and erratic in occurrence, while there is a marked tendency for the thunder clouds to bank up on the south-western horizon, which would seem to indicate that there is frontal activity where the warm moist air from the north-east and east encounters the warm dry continental air. The general rains which occasionally occur over the plateau (see Fig. 19) and especially near the Escarpment during summer are considered to be frontal, most probably associated with the more gradual ascent of hot and humid Equatorial air over the warm Tropical Continental air. The occasional winter rains experienced over the Highveld are likewise thought to be frontal, occurring as they do when the normal anticyclone moves north-eastwards up the coast and is replaced temporarily by a col between a tongue of low pressure over the interior and a low moving up the coast. Under these conditions the wind direction changes suddenly from northerly to southerly at the passage of the trough, and it

seems likely that the cold southerly current undercuts the warm northerly one along a cold front, thereby causing condensation in the uplifted air mass.

Local weather phenomena which exert an important influence on the climate of the coastal areas appear to be due to the establishment of certain relationships between the air masses from the plateau and those from the oceans. The most important are berg winds[8, 9] and the fogs along the coast of South West Africa.

Sometimes the warm dry air mass from the plateau moves out over the marginal land and gives rise to the formation of a steep temperature inversion where it overlies the cooler and denser air from the sea. Following a night of active radiation in winter, the temperatures in the morning are usually around 50° F. along the Namib coast and some 10° F. higher in Natal. As the effects of the incoming insolation are felt the air near the surface heats up rapidly until the inversion is broken down. Turbulent mixing of the surface air with the upper air then takes place freely, and is accompanied by an off-plateau wind – the berg wind – a rapid rise in temperature, to over 90° F. and on occasions to more than 100° F., and hazy conditions. The very high temperatures result from the fact that the air at the height of the plateau has been warmed already by contact with the surface, so its temperature is higher than the normal in the upper air, while it is further warmed as it descends to the coastal areas. The maximum temperatures are usually reached before noon,[8] probably as the inversion is broken down, after which there is a sharp drop as turbulent mixing proceeds. The winds are often strong and gusty but they normally die down in the evening and are rarely able to prevent the formation of a ground inversion during the ensuing night.

The coastal belt of South West Africa is notorious for its great aridity and the prevalence of fog.[10, 11] Temperatures are low for the latitude and curiously enough generally rise after the south-south-westerly sea breeze, blowing off a sea chilled by the cool Benguela current, has set in. The explanation of all these phenomena appears to lie in the relationship between the air masses affecting the area. It appears that the cool maritime air mass from the Atlantic moves in over the coastal lands below the Escarpment while the Tropical Continental or Superior air from the interior, warmed as a result of contact with the heated plateau surface, moves out at a high level and overlies it. The former is relatively thin, being about 2,000 feet thick, cool and moist, with a lapse rate approximately equal to the saturated adiabatic; the latter, thicker, extending for 10,000 feet or more, is warm and dry and characterized by a lapse rate which approaches the dry adiabatic. Between the two there is a marked inversion of temperature of some 10° F. (Fig. 25). Within the layer of moist air near the surface there is usually sufficient turbulence to cause the formation of a layer of stratus cloud, the base of which is somewhere between 800 feet and 1,000 feet above the surface and has a thickness of some 1,000 feet. But the vertical distribution of temperature is such as to give rise to exceeding stable conditions; radiation at night results in low surface temperatures and it seems likely that the fine drizzle falling from the

cloud into the cool air below gives rise to the formation of fog extending from the surface to the lower limit of the cloud. These conditions are particularly characteristic of the summer months when the mornings are usually cool, with a temperature around 50° to 55° F., cloudy and foggy, with only a very light breeze blowing from a north or north-north-easterly direction. As the day proceeds the wind backs gradually, becoming westerly by midday and south-south-westerly in

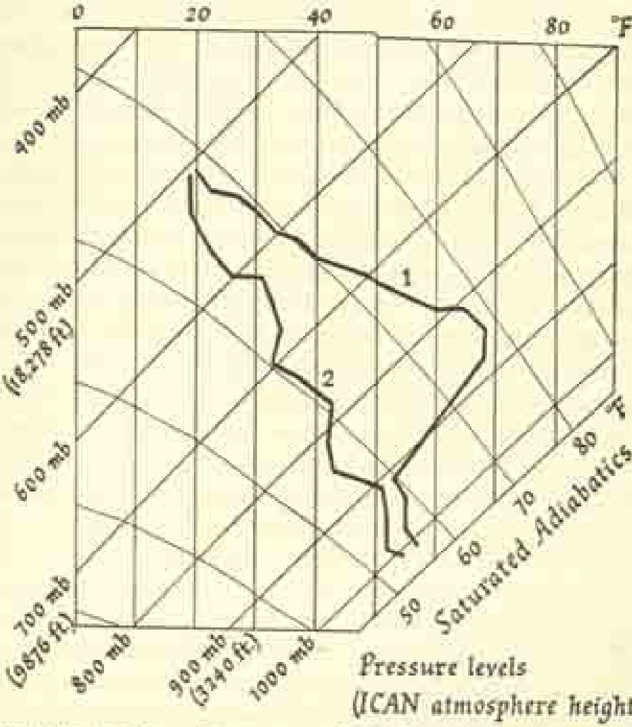


Fig. 25. Upper air observations over Walvis Bay during fog (3 Nov. 1939).

the early afternoon; at the same time it increases in strength and produces local dust storms. The fog disperses and the temperatures rise. This sequence appears to occur when there is an anticyclone over the Atlantic so that the wind is due to a combination of the sea breeze and gradient wind. It seems likely that the strength of the wind is sufficient to cause turbulent mixing up to and beyond the inversion, which is thereby broken down; the consequent mixing of the warm dry air above, with the cooler air below is responsible for the rise of temperature experienced at the surface.

Fogs are infrequent along the east coast for the air masses brought in from over the Indian ocean are warm and there is a normal temperature gradient from the lower to the upper air. In the foothill belt of the Drakensberg, however,

where the relief barrier causes the uplift of the warm moist air from the Indian ocean, mist and fine drizzle are frequent.

We have seen how the weather conditions depend on the properties and behaviour of the air masses over the sub-continent. The climate results from the frequency of each set of conditions, which determines the distribution of temperature and rainfall. These distributions are influenced by the great elevation and vast extent of the plateau, the abrupt nature of the Escarpment and by the fact that the east coast is washed by the warm Agulhas current and the west coast by the cool Benguela current, but their influence is indirect and operates only through the air masses.

The first apparent effect of the extent of plateau is the remarkable uniformity of mean annual temperature over the greater part of the country, Cape Agulhas, the most southerly point in latitude 34° 50′ S. and 62 feet above mean sea-level, registering a mean yearly temperature of 61° F. while Johannesburg, nearer the equator in latitude 26° 11′ S. at an elevation of 5,735 feet, has an annual mean of 60° F., a difference of 1° F. Similarly the apparent effect of the differing ocean currents is seen in the higher mean annual temperature of Durban, 69·8° F., on the east coast compared with Port Nolloth, 57·6° F., in roughly the same latitude but on the west coast, and in the decrease in temperature from south to north along the coast of South West Africa compared with the more normal increase along the Natal coast. The highest mean temperatures – over 70° F. – are experienced near the mouth of the Orange river and in the Lowveld of the eastern Transvaal. But the means mask great seasonal and diurnal variations in the temperature conditions from one part of the country to another.

During the winter months there are marked differences in the temperature conditions between the marginal lands and the plateau (Fig. 26). In the former the mean temperatures decrease from over 55° and 60° F. respectively along the south and east coasts to about 50° F. at the foot of the Escarpment. Here there is a sharp fall. Over the plateau they are generally between 45° and 50° F., but fall below 45° F. on the high ground of the Drakensberg and increase to over 55° F. towards the lower interior lands of the Kalahari. Altitude might appear to exert the greatest influence over temperature distribution but when the mean maxima and mean minima for these months are examined a different picture is revealed. The differences in the mean temperatures result mainly from the minima experienced. In the coastal districts of the east and south the latter are generally around 50° F. but they decrease inland to less than 30° F. over the greater part of the Highveld and to less than 20° F. in the higher areas of the Drakensberg. On the other hand there is little difference in the mean maximum temperatures, which generally decrease from 75° to 65° F. from north to south along the coast and from the coast inland reaching a little less than 60° F. in the most elevated areas. The range of temperature increases from less than 15° F. along the coast to more than 30° F. on the south-western part of the plateau. The difference between the plateau and the marginal lands is marked. An interesting feature is the greater

range in the Lowveld compared with the Drakensberg foothills above, no doubt explained by higher maxima associated with lower elevation in the Lowveld and by differences in air drainage on calm clear nights. The west coast is characterized both by low minima and low maxima, while the range is small. These differences

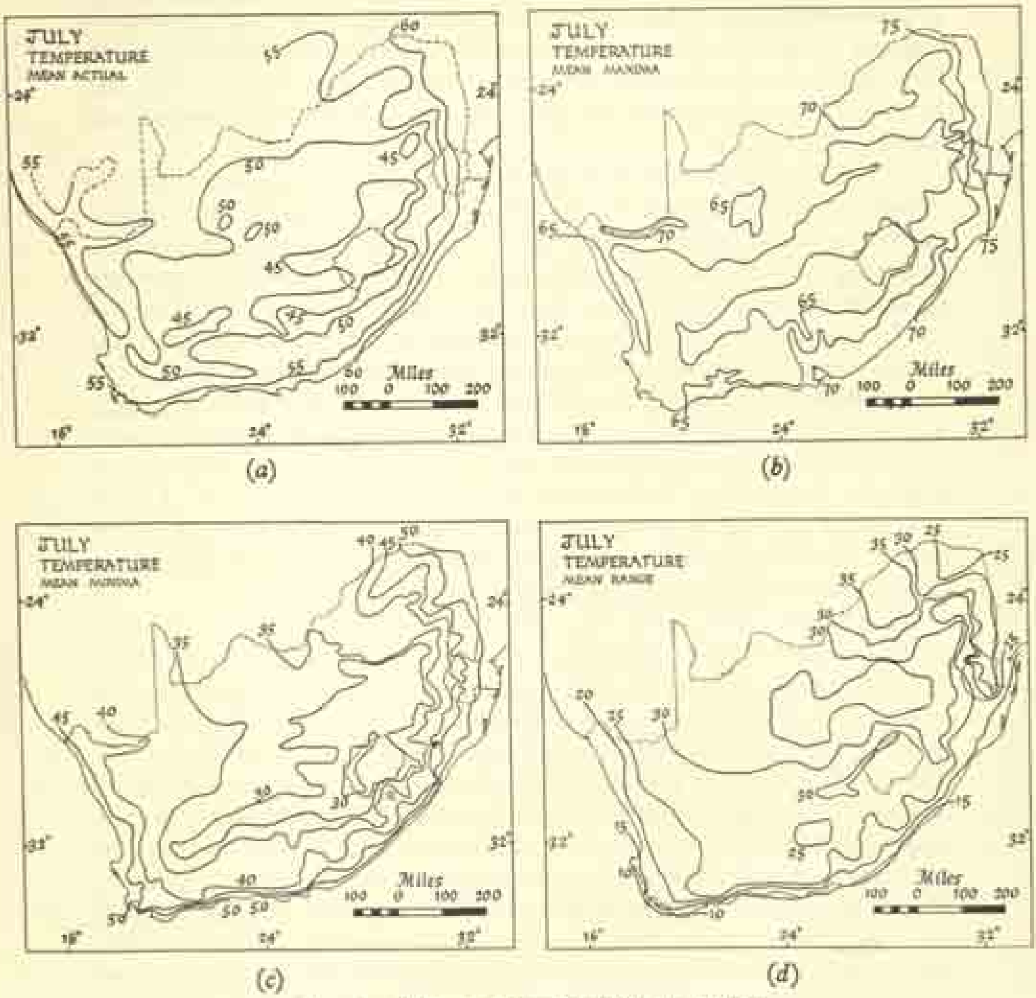
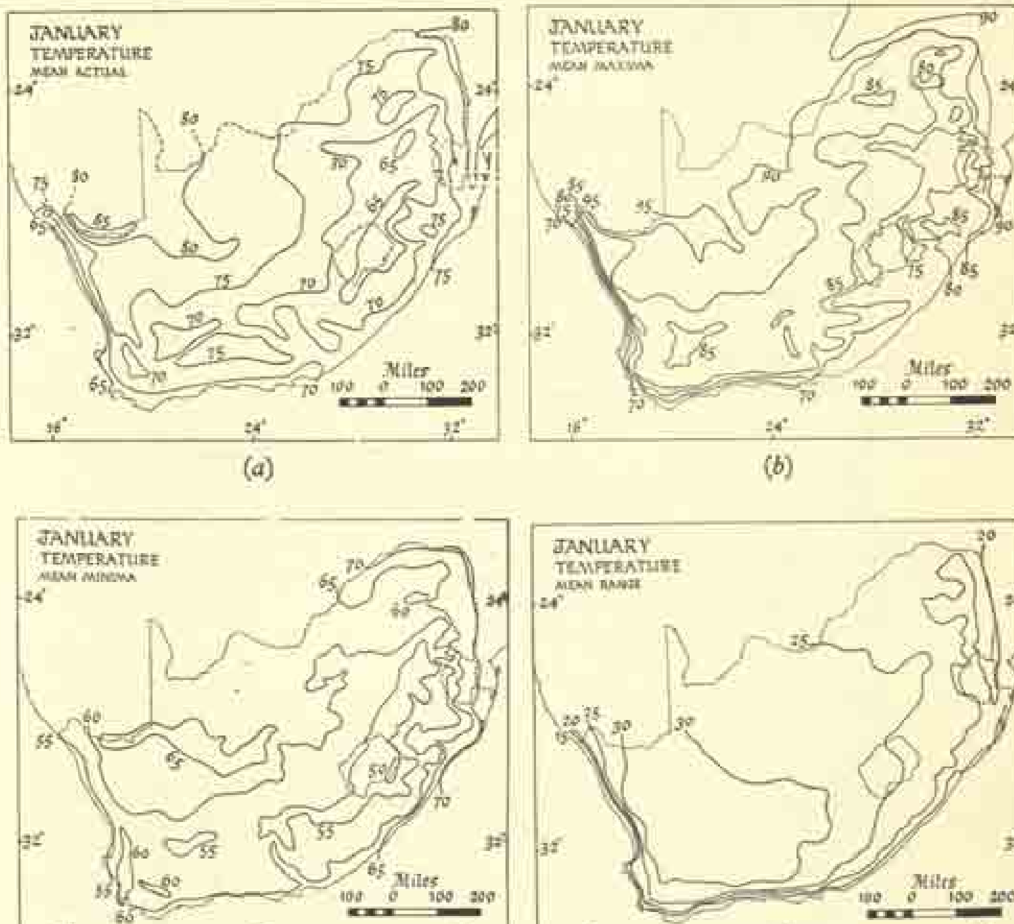


Fig. 26a–d. Temperature conditions in July.

in the temperature conditions between the plateau and the marginal lands are due essentially to the differing properties of the air masses affecting them. Thus the plateau is consistently under the influence of the excessively dry superior air, the skies are exceptionally clear; abundant sunshine gives rise to high day temperatures, but rapid terrestrial radiation results in low nightly minima. In the

coastal areas the air is moister, less insolation gets through by day, while the loss of heat by terrestrial radiation at night is less; hence the smaller diurnal variations of temperature. Frost is practically unknown in the coastal areas but occurs inland, becoming more frequent towards the Escarpment (Figs. 28 and 29). On



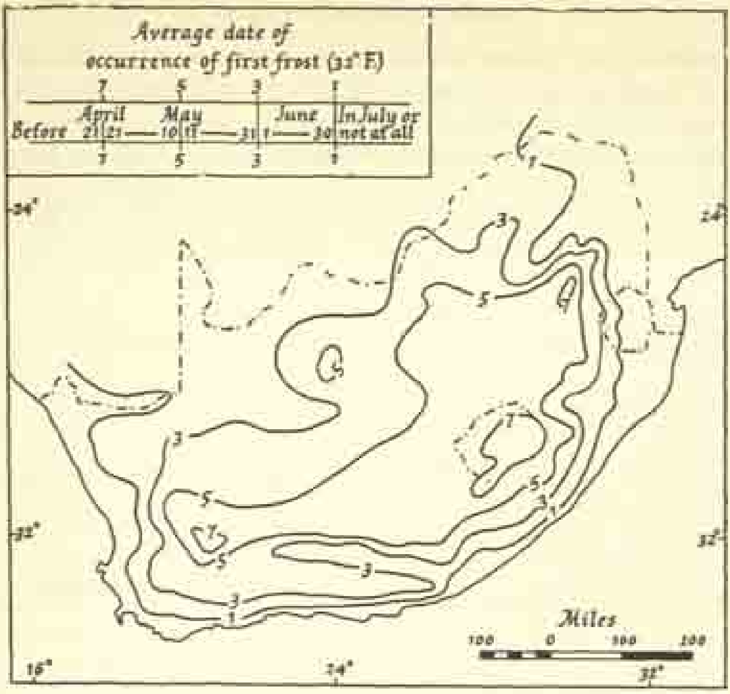
(a) (b)

(c) (d)

Fig. 27a–d. Temperature conditions in January.

the eastern plateau the mean duration of light frost (37° F.) is over 150 days and that of severe frost (27° F.) over 60 days while in the mountains and valleys near the Escarpment the figures are respectively 240 and 120 days.

During the summer months the apparent influence of the sea is less marked than during the winter. The mean temperatures along the southern and eastern



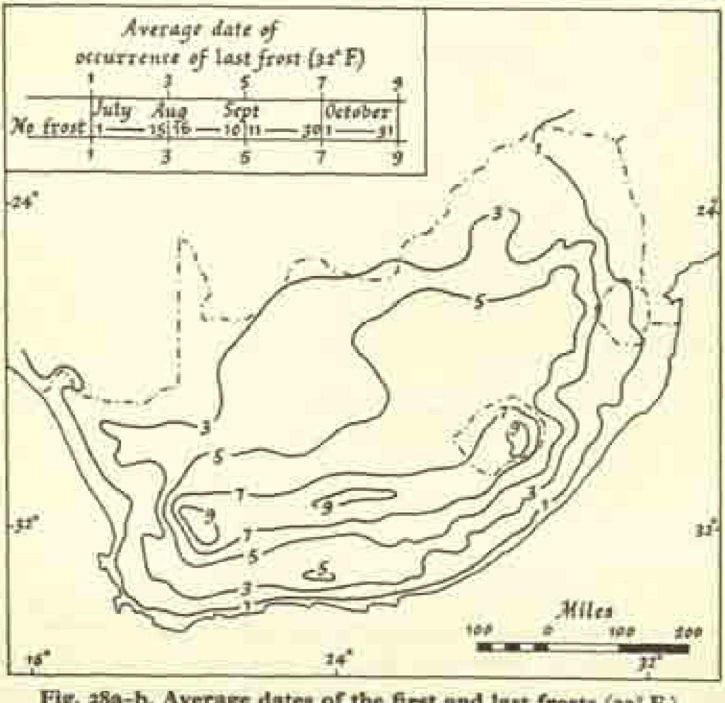


Fig. 28a-b. Average dates of the first and last frosts (32° F.).
(After the South African Meteorological Office.)

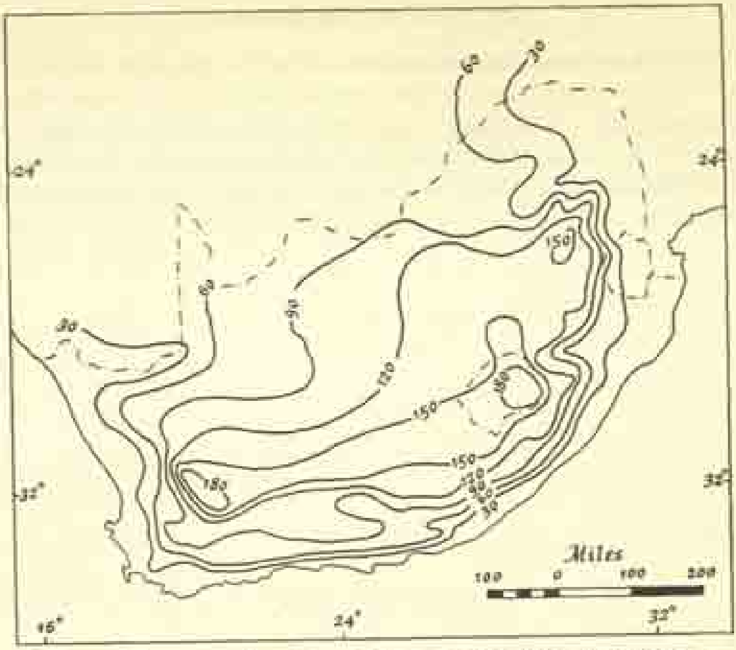


Fig. 29. The mean duration of the frost (32° F.) period in days.
(After the South African Meteorological Office.)

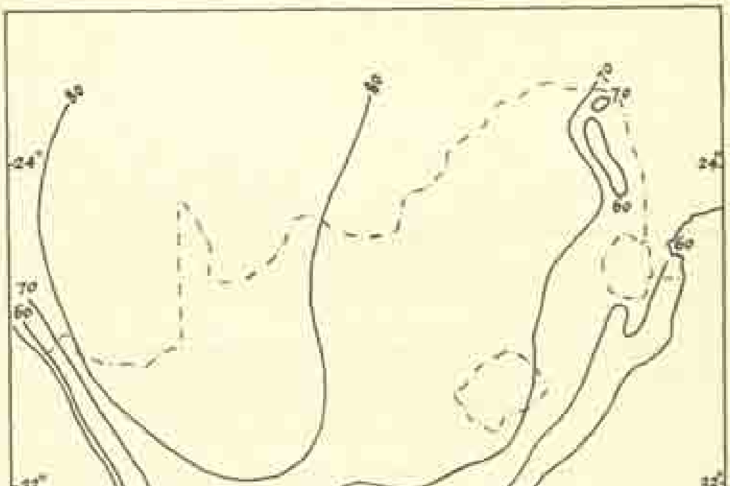


Fig. 30. The average annual duration of sunshine.
Expressed as a percentage of the possible sunshine. (After B. R. Schulze.)

coastal districts are again higher than those along the west coast but there is less difference between the plateau and the marginal lands (Fig. 27). This is due to the fact that during this season moist air from the Indian ocean is carried over the plateau with the result that similar weather conditions are experienced over the entire eastern part of the sub-continent. The west coast is again under the influence of the moist air mass from the Atlantic. There are, however, regional

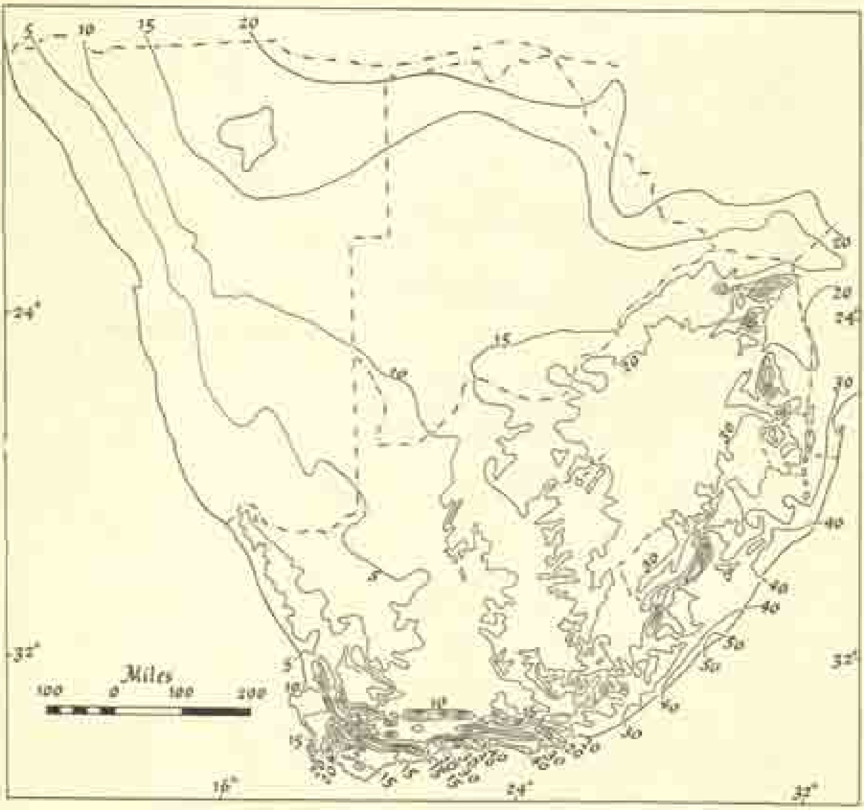


Fig. 31. Distribution of mean annual rainfall, in inches.
(After the meteorological staffs of the Royal Navy and South African Air Force, courtesy of the Government Printer, Pretoria.)

differences in the range of temperature. Thus the highest mean maxima are experienced over the Kalahari where the atmosphere is much drier than elsewhere and in the Lowveld where the low latitude and low altitude are the controlling factors. In these regions maxima over 90° F. and in places over 95° F. are usual while on a number of occasions in each month the temperatures rise above 100° F. or even 105° F. Enclosed basins like that of the Tugela river near Ladysmith also experience high maxima. The lowest maxima, below 75° F., occur

along the western and southern coasts and on the high ground of the Roggeveld, Drakensberg, and the Soutpansberg. The moderating influence of the warm moist air mass is seen in the high mean minima – between 70° and 60° F. – along the eastern and southern coast while the protection of the valleys of the south-western Cape from Atlantic influences results in their relatively high minima.

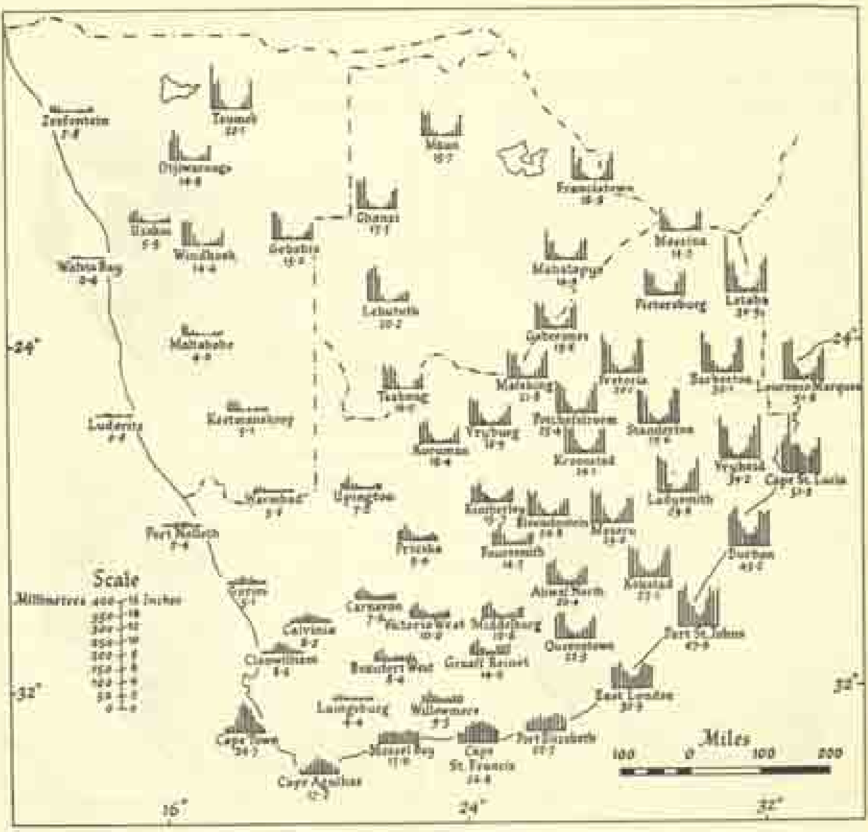


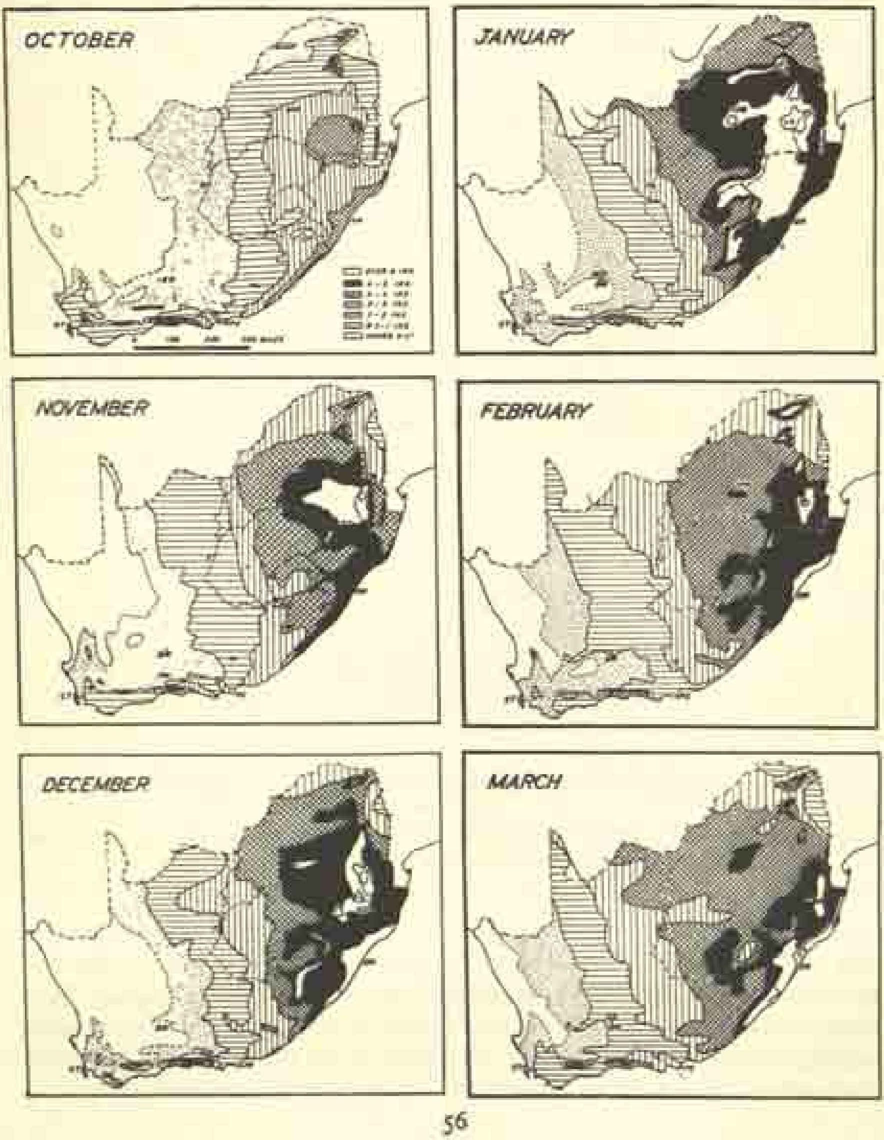
Fig. 32. Mean monthly and mean annual rainfall at selected stations in Southern Africa.

(After the meteorological staffs of the Royal Navy and South African Air Force, courtesy of the Government Printer, Pretoria.)

Altitude is responsible for the low minima – below 55° F. – on the eastern plateau. The map showing the range of temperature during January presents a number of interesting points. Generally speaking the range increases from about 15° F. in the coastal districts to more than 35° F. in inland locations. The greatest range actually occurs towards the west of the plateau, along the Caledon valley and in the Lowveld of the northern and eastern Transvaal. In the first mentioned area it

probably results from the generally drier atmosphere towards the interior permitting active radiation, while in the others it is probably due to the accumulation of 'cool' air at night on days when the air is relatively dry. In this connexion the small range in the foothills below the Escarpment is noteworthy.

Throughout the year there is abundant sunshine (Fig. 30). During the dry season the skies are clear for days on end and the maximum amount is received. Even during the rainy season sunshine occurs on most days for the rainfall comes



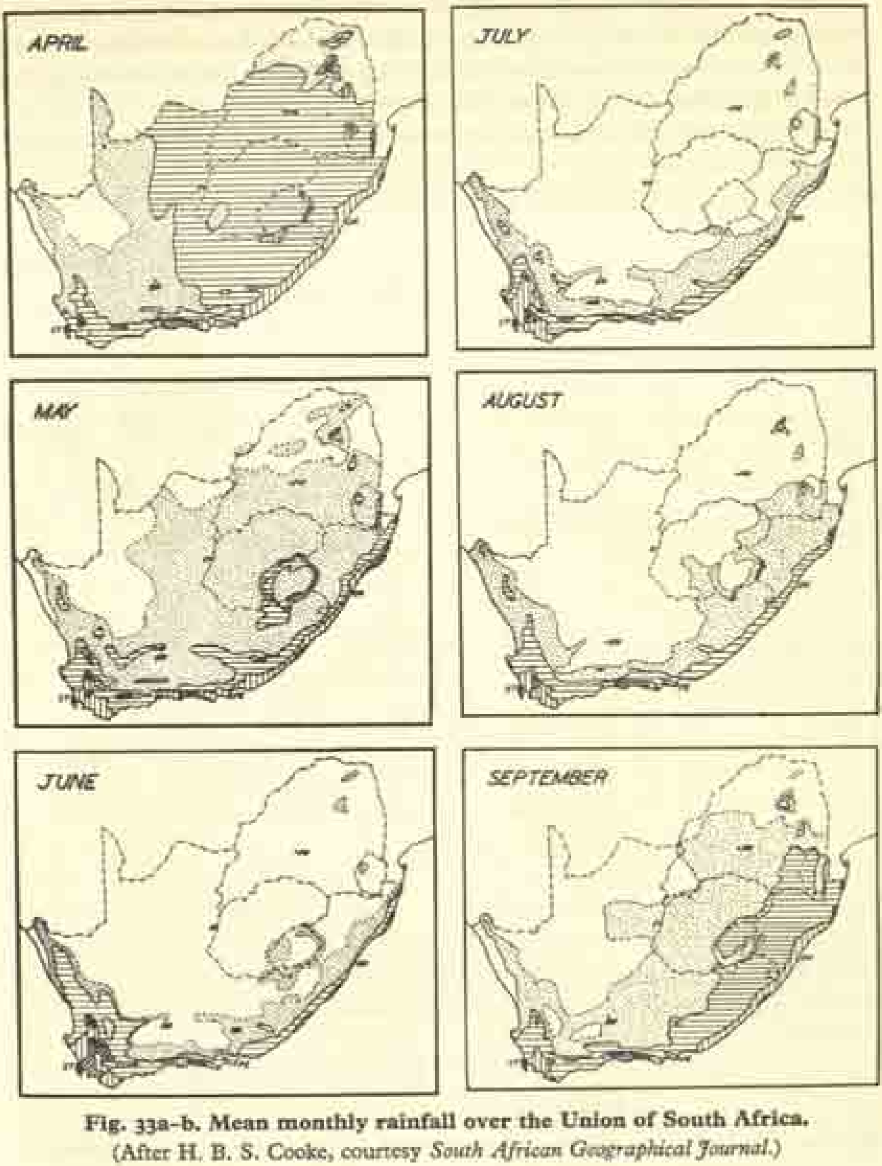


Fig. 33a–b. Mean monthly rainfall over the Union of South Africa.
(After H. B. S. Cooke, courtesy *South African Geographical Journal.*)

sporadically in showers of short duration, after which the skies quickly clear. In the summer rainfall area the storms tend to come in the late afternoon and early evening after bright sunny days so that little of the insolation is lost. Generally speaking the total amount of sunshine increases towards the interior as the amount of rainfall and of cloud cover decreases.[15]

Despite the fact that the rainfall[13, 14] over the eastern half of South Africa falls in thunderstorms and that in the south-western and southern Cape comes during the passage of depressions, the amount received depends very largely on altitude and distance from the sea. The amount generally decreases from the east and south coasts inland towards the Escarpment (Fig. 31). Here on the upper

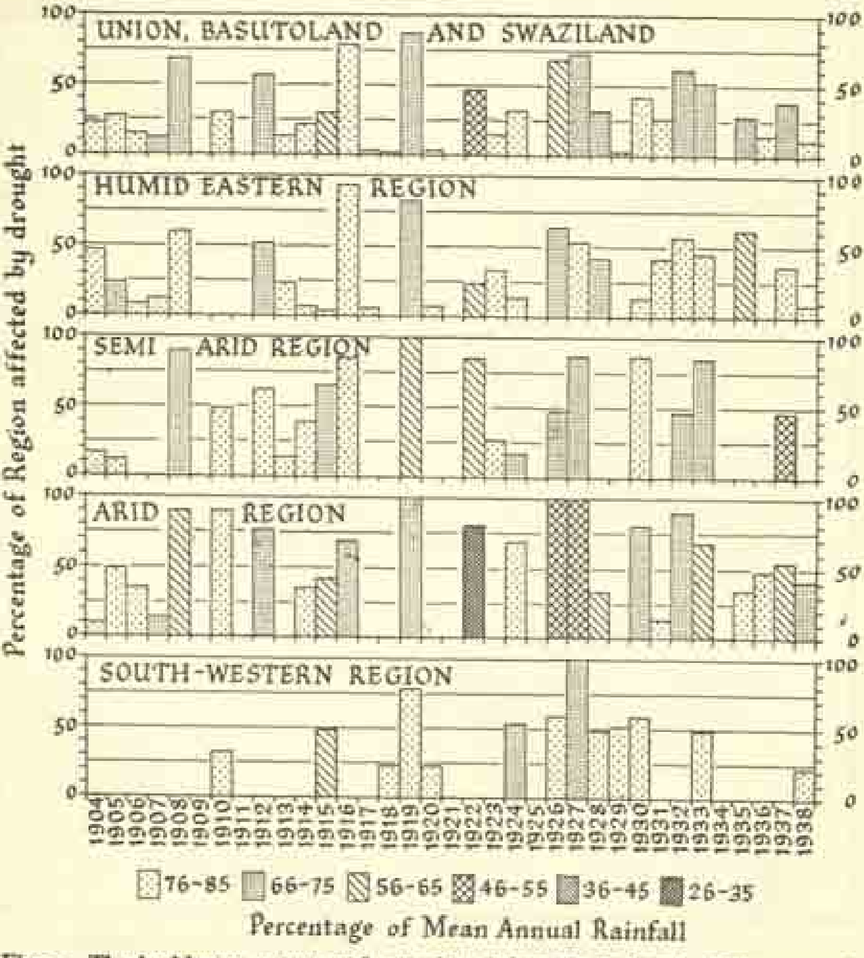


Fig. 34. The incidence, extent and severity of drought in South Africa 1904–38.
(Adapted from L. Levinkind.)

seaward facing slopes the highest falls are experienced, exceeding 70 inches per annum in places. The amount then decreases towards the interior and west. More than half of the country receives less than 15 inches while vast stretches in the west receive less than 5 inches. In the south-western and southern Cape the amount varies considerably within short distances owing to the juxtaposition of

high mountains and enclosed valleys. There can be little doubt that in the vicinity of the Escarpment and Cape mountains a good deal of the rainfall is due to the orographic displacement of air masses brought in from over the oceans. The decrease in rainfall towards the interior and west is probably explained by the fact that a predisposing factor in the summer rainfall experienced over the plateau is the arrival of warm moist air from the Indian ocean or the equatorial lowlands and that only rarely does this penetrate to the interior. The aridity of the west

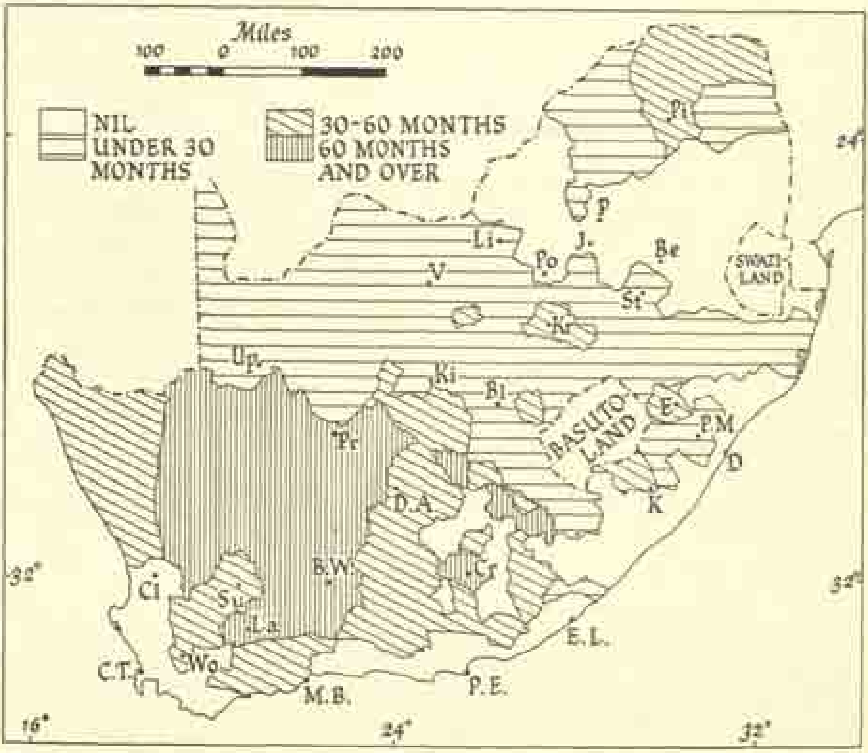


Fig. 35. Areas of the Union of South Africa declared 'drought-stricken' 1926–39.
(After S. J. de Swardt and O. E. Burger.)

coast is due to the persistence of stable conditions as the warm dry air from the plateau overlies the cool moist air from the Atlantic. Generally speaking the number of rainy days closely conforms to the distribution of the total fall, being greatest near the Escarpment and decreasing towards the interior. Over the greater part of the country the rainfall is concentrated in the summer months and the winters are remarkably dry, but the south-western Cape experiences a winter maximum while rainfall occurs throughout the year in the southern and eastern coastal regions with a tendency for the summer maximum to become more pronounced towards the north (Figs. 32 and 33).

Except in the southern Cape the rainfall is notoriously unreliable.[14, 15] This would appear to be due to the fact that the occurrence of summer rainfall depends on the arrival of moist air from the east and north, which in turn depends on the weakening of the anticyclone and the development of strong easterly and north-easterly winds. The general feebleness of the circulation has already been noted and the persistence of the anticyclone or any lessening in the wind force resulting in a reduction in the supply and penetration of moist air would cause the droughts

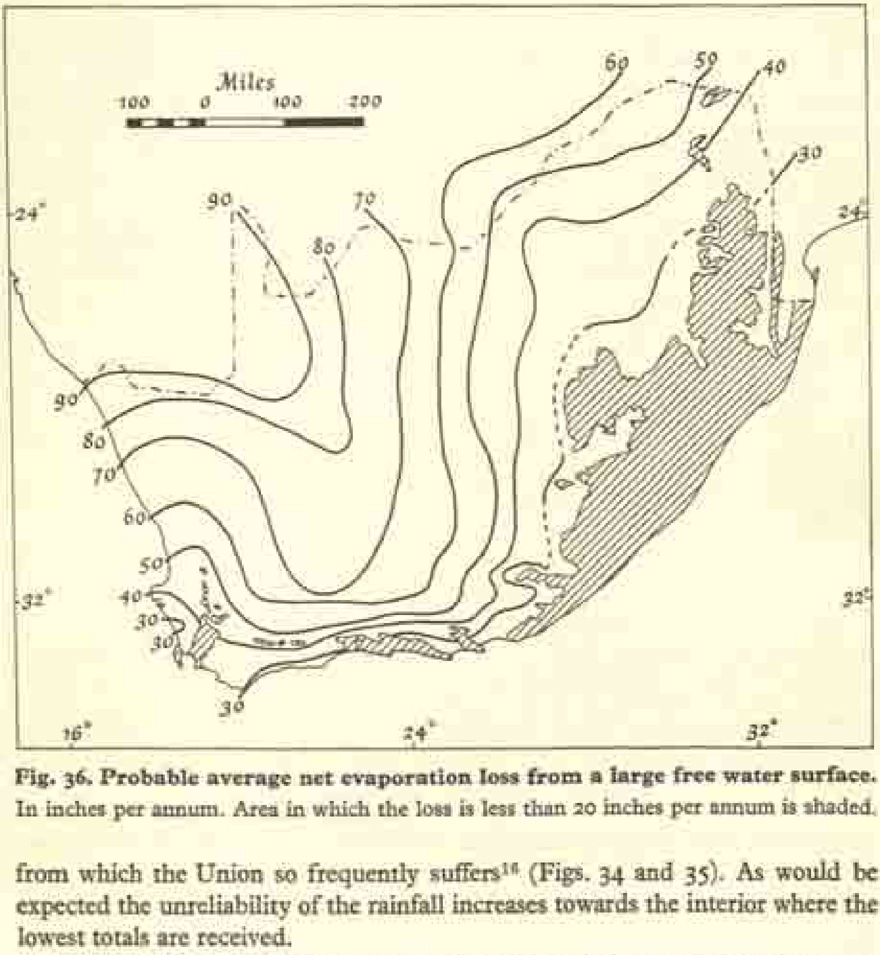


Fig. 36. Probable average net evaporation loss from a large free water surface. In inches per annum. Area in which the loss is less than 20 inches per annum is shaded.

from which the Union so frequently suffers[16] (Figs. 34 and 35). As would be expected the unreliability of the rainfall increases towards the interior where the lowest totals are received.

Because of high temperatures and abundant sunshine evaporation is intense over the whole of South Africa. Even in the better watered areas the loss from a free water surface exceeds the annual rainfall and in the heart of the interior it exceeds it tenfold. Little is known about the loss of moisture from the soil by evaporation but experiments undertaken at Pretoria in the humid eastern part of

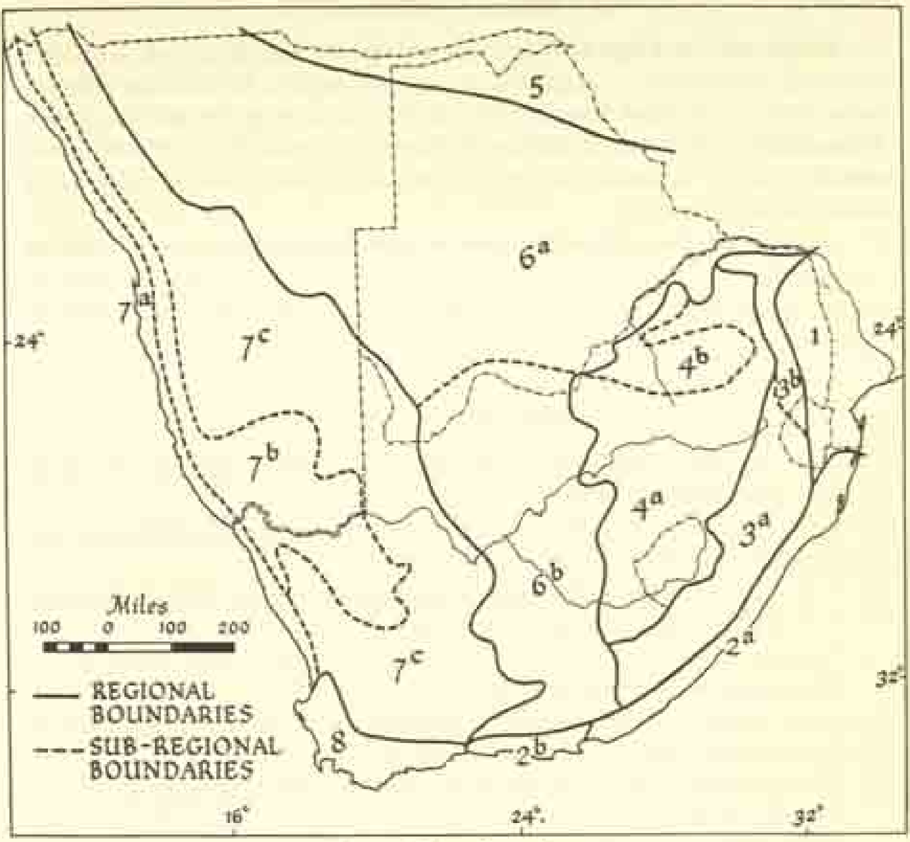


Fig. 37. Climatic regions.

(After S. P. Jackson)

1. *The Lowveld* with very hot rainy summers and warm dry winters. 2. *The equable Sub-Tropical Coastlands of Natal and the South-Eastern Cape:* 2a. The Sub-Tropical Coastlands of Natal with a summer rainfall regime; 2b. The Warm Temperate Coastlands of the South-Eastern Cape with an all-season rainfall regime. 3. *The Eastern Plateau Slopes* characterized by a summer rainfall regime and seasonal extremes of temperature but showing great variations of temperature and rainfall with differences of relief from place to place: 3a. The Plateau Slopes of Natal and the Eastern Cape which receive some rainfall at all seasons but are liable to very low temperatures and frost in winter; 3b. The Plateau Slopes of the Eastern Transvaal where there is a greater contrast between the wet and dry seasons but where the winter temperatures are somewhat higher. 4. *The Eastern Plateau* characterized by sharply contrasted seasons—warm rainy summers and cool, dry winters—abundant sunshine, great diurnal changes of temperature and low rainfall: 4a. The Highveld with relatively cool summers and very cold winters with frequent frost; 4b. The Bushveld with higher temperatures throughout the year and freedom from severe frost. 5. *The Plateau of Northern Bechuanaland, Rhodesia etc.* with hot rainy summers and cool dry winters. 6. *The Semi-Arid Plateau Interior* characterized by low and unreliable rainfall and great extremes of temperature: 6a. The Kalahari where the rainfall is concentrated in summer and the winters are rainless; 6b. The Interior of the Union where the rainfall is more evenly distributed, particularly towards the south, and where the winter temperatures are considerably lower than in the Kalahari. 7. *The Deserts of Southern Africa:* 7a. The cool foggy Coastal Namib; 7b. The hot, dry Interior Namib; 7c. The Semi-Desert Country of South West Africa, the Karoo and North-Western Cape characterized by great extremes of temperature and very low rainfall but less extreme aridity than the Namib. 8. *The South-Western Cape* with hot dry summers and cool rainy winters.

the country indicate a high rate, involving a net loss of moisture, i.e. evaporation in excess of precipitation, in relatively dry summer months. In the drier areas the losses must be very high indeed. It is in fact the desiccating effects of the intense evaporation which makes any failure in the time of arrival and in the amount of rainfall received so serious and causes droughts of even short duration to be disastrous to the farmers.

As is to be expected over so great an area and one experiencing differing rainfall regimes a number of climatic regions may be distinguished. These are shown in Fig. 37 but their climatic conditions will be considered in the regional text.

BIBLIOGRAPHY

1. S. P. JACKSON. 'Atmospheric circulation over South Africa'. *S.A.G.J.*, Vol. XXIV, 1952, pp. 48–60.
2. S. P. JACKSON. 'A preliminary study of the atmospheric circulation over South Africa.' *Ph.D. Thesis*, London. 1951.
3. T. E. W. SCHUMANN. *Atmospheric Pressure and Weather Charts*. Union of S.A. Meteorological Office, Pretoria. 1941.
4. See also G. W. COX. *The Circulation of the Atmosphere over South Africa.* Met. Mem. No. 1, Pretoria. 1935.
5. S. P. JACKSON. 'Air masses and the circulation over the plateau and coasts of South Africa.' *S.A.G.J.*, Vol. XXIX, 1947, pp. 1–15.
6. Meteorological Services of the Royal Navy and South African Air Force. *Weather on the Coasts of Southern Africa*, Vol. II, Pt. 2, 'Union of South Africa from Olifants River to Mossel Bay'. 1943.
7. S. P. JACKSON. 'Notes on the occurrence of cold snaps at Johannesburg. *S.A.G.J.*, Vol. XVI, 1933, pp. 27–38.
8. Meteorological Services of the Royal Navy and South African Air Force. *Weather on the Coasts of Southern Africa*, Vol. II, Introduction and Pt. 1, 'Local Information'. 1944.
9. M. P. van ROOY. 'The influence of berg winds on the temperatures along the west coast of South Africa.' *Q.J. Royal Met. Soc.*, Vol. LXII. London. 1936.
10. S. P. JACKSON. 'A note on the climate of Walvis Bay.' *S.A.G.J.*, Vol. XXII, 1941, pp. 46–53.
11. J. J. TALJAARD and T. E. W. SCHUMANN. 'Upper air temperatures and humidities at Walvis Bay, South West Africa.' *Bull. Amer. Met. Soc.*, Vol. XXI, No. 7, 1940.
12. B. R. SCHULZ. *Sunshine and Cloudiness in South Africa.* Union of South Africa Weather Bureau. Dept. of Transport. Pretoria. 1950.
13. See H. B. S. COOKE. 'Some observations on rainfall distribution in S.A.' *S.A.G.J.*, Vol. XXVIII, 1946, pp. 34–8.

14. See T. E. W. SCHUMANN. *District Rainfall*. Union of S.A. Weather Bureau. Dept. of Transport. Pretoria. 1949.
15. F. E. PLUMMER. *A preliminary investigation into the variability of the rainfall of the Transvaal*. Transvaal University College, Bull. No. 12, Pretoria, 1927.
16. L. LEVINKIND. 'Droughts in South Africa.' *F. in S.A.*, Vol. XVI, No. 180, 1941.

3

Vegetation

Several distinct types of vegetation (Fig. 38) may be recognized in South Africa and their distribution correlated in a general way with the prevailing climatic conditions with certain modifications introduced by relief and soil influences. Thus the distribution of sclerophyllous bush appears to be broadly coincident with the area experiencing a winter rainfall regime; forest, savanna, and desert scrub are restricted to the warmer areas while grassland prevails where the winter temperatures are low. The progressive change from forest to savanna and desert scrub may be linked with decreasing rainfall, the contrast between the short grassveld of the Highveld and the tall grassveld of the Middleveld may be explained by the ability of the former to withstand the low winter temperatures of the high plateau.

The general pattern of the relationship between vegetation type and climate is, however, upset by the occurrence of sour grassveld and apparently drought-resistant bushveld and thornveld in the warm well-watered areas of the eastern plateau slopes, by the presence of macchia in the southern Cape with its all-season rainfall and of desert scrub in the humid coastal area near Port Elizabeth. The occurrence of these vegetation types in these regions cannot be simply explained either in terms of climatic or edaphic conditions. Nor can the fact that proteas (Proteaceae), which are characteristic of the Cape macchia (or *fynbos* as it is locally called), also occur scattered through the grassveld of the Drakensberg Middleberg plateau (Plate 22) and are found again on the quartzite ridges of the southern Transvaal.* To understand these anomalous distributions due consideration must be given to the dynamic character of the vegetation, continually undergoing changes in its composition as a result of normal succession, of modifications in the habitat – such as those caused by climatic change or alterations in the drainage or edaphic conditions – and, above all, of man's interference.

Recent studies, on a statistical basis, of the composition of the vegetation in

* Prof. R. S. Adamson does not consider that the presence of Proteaceae as such can be taken to indicate the former existence of *fynbos*, especially as the species occurring in the Drakensberg are distinct from those in the Cape flora proper. He recognizes a phytogeographic link but not one that can be pressed far ecologically.

1. View northwards to the Magaliesberg showing the poort cut by the Hex river (one of the headstreams of the Crocodile river) and used as the site of the Olifants Nek dam. The ranges trend E.–W., whereas the main rivers flow S.–N., suggesting drainage superimposition from a cover of younger rocks.

2. One of the headstreams of the Sabie river dropping over the Great Escarpment in the Pinnacle Falls near Graskop. The Highveld plateau surface is grass covered but note the indigenous forest in the kloof and the cycads or tree ferns on the lip of the Escarpment and along the stream bank. In the background forestry plantations over the Highveld.

3. View up the Elands river valley from Kaapsche Hoop road. Rising on the Highveld the river drops over the Pretoria quartzite Escarpment (background) by the falls at Waterval Boven. After meandering over the level alluvial valley (centre) it trenches the high ground formed by Black Reef quartzite and Primitive rocks to join the Crocodile river. These features suggest drainage superimposition.

4. View over the Transvaal Lowveld to the Krokodilpoort ranges showing the gorge cut through them by the Crocodile river. The course of the river, here flowing over the Old Granite, is unrelated to the present surface features.

5. One of the headstreams of the Umkomaas river near Bulwer, showing the waterfalls which occur where the stream crosses a dolerite sill. Both above and below the outcrop of the dolerite the stream gradient is gentle over Karoo sedimentary rocks.

6. The Cedarbergen. View north-westwards down Bosch Kloof with the Middleberg ranges with Pyramid Peak (4,979 feet), on the western side (left). In the foreground surviving Clanwilliam cedar trees (*Widdringtonia juniperoides Endl*).

7. Plettenburg Bay, the lower Keurbooms river, the coastal plateau and the Tsitsikama mts. Sand dunes block the mouth of the river. Inland the river is incised 700 feet into the coastal plateau but its valley is filled with Cretaceous and Tertiary sediments and its old course is 60 feet below sea level. These features suggest emergence following peneplanation of the coastal plateau in Tertiary times.

8. Mossel Bay, protected on the south by Cape St Blaize where the Table Mountain Sandstone reaches the sea. The town has grown up on a marine-cut terrace. Large vessels, unable to dock here, anchor offshore and lighters, seen in the harbour, ply between them and the shore. Bitter aloes obtained from wild plants (left foreground) are exported.

9. The Monts-aux-Sources amphitheatre. A winter scene with snow on the High Berg; on the right is the Sentinel Peak and on the left the Eastern Buttress. In the middle distance is the National Park hostel.

10. View across the Middleberg plateau cut across rocks of Beaufort age to the High Berg dominated by Cathkin Peak (10,438 feet) built of Stormberg lavas. Note that the kloofs carry forest whereas the level surfaces are grass covered.

11. The Great Escarpment at Kaapsche Hoop where its strong development is due largely to the resistance to erosion of the Black Reef quartzite, dipping gently westwards and overlying Old Granite. Below the Escarpment is the Barberton Basin underlain by Old Granite, with the Barberton mountains built of Archaen rocks of the Primitive Systems rising in the background.

12. Mangroves occupying the swamps fringing Lake St Lucia, the open waters of which may be seen in the right background.

13. The coastal vegetation, Winkle Spruit, Natal. On the sand dunes *Ipomoea biloba* (left centre) and *Mesembryanthemum* sp. (right centre) take hold. They are succeeded by *Passerina rigida* (right foreground), which passes to wind-shorn low scrub composed mainly of *Gymnosporia* spp. (right foreground), which in turn is replaced by tropical forest.

14. The coastal vegetation, Winkle Spruit, Natal. The fore-dunes are covered with low wind-shorn scrub. This is succeeded inland by the coast bush with the palms *Strelitzia augusta*.

15. Tropical coastal forest near St Lucia.

16. Temperate forest in the Knysna area. The tall trees are yellowwoods (*Podocarpus* spp.).

17. The undergrowth in the Knysna forest. The light-coloured plant in the foreground is *Helichrysum* sp., the tree fern is *Hemitelia capensis*.

18. The sclerophyllous bush of the south-western Cape, showing in the foreground *Berzelia* spp. and *Brunia* spp. The larger bushes in the background are *Protea* spp.

19. *Protea* sp. in the sclerophyllous bush of the south-western Cape.

20. Tall grasses (constituting sour grassveld), with scattered *Protea* spp. on the Eastern Plateau Slopes of the Natal Drakensberg near Cathkin Park. Note the temperate evergreen forests occupying the kloofs.

21. Remnants of temperate evergreen forest in the Nkandhla area of Zululand.

22. General view of the Natal thornveld near Pietermaritzburg. As in this photo this type of vegetation characteristically occupies the hot semi-arid valley bottoms.

23. Typical parkland savanna in the Transvaal Lowveld in winter. The grass has died down and the cover is relatively open. In the foreground is a jackal.

24. Dense tangled savanna in the eastern Lowveld. Two impala may be seen in the foreground.

25. Savanna vegetation composed of thorny acacias and tropical grasses in the Bushveld Basin near Rustenburg in late summer.

26. The Kalahari thornveld between Mafeking and Lobatsi on the borders of the Union of South Africa and Bechuanaland Protectorate.

27. Karoo vegetation composed mainly of low shrubs near Prince Albert Road. *Moraea* sp. in flower.

28. Valley bushveld composed mainly of *Aloe* spp. (centre), *Euphorbia* spp. and *Portulacaria* spp. along the Buffalo river between East London and Kingwilliamstown.

all parts of the country and in particular of relict communities, suggest that forest and scrub forest were formerly much more extensive; probably in the recent past they covered the greater part of the area between the Great Escarpment and the sea in the south and east whereas today *fynbos* clothes most of the well-watered slopes of the Cape ranges and grassveld, thornveld and bushveld alternate throughout the marginal belt of the eastern Cape and Natal. Sweet grassveld was formerly more widespread, in particular extending westwards into the area now occupied by Karoo types of vegetation (desert scrub); the latter were formerly more restricted in their distribution.

In attempting to explain these changes due consideration must be given to the origin and distribution of the floras contributing to the present vegetation formations. Two main floras may be recognized – the Cape flora, forming the sclerophyllous bush (*fynbos*), and forest of the winter rainfall area and the Tropical flora embracing the tropical forest, savanna, and grassveld of the summer rainfall area. The Karoo vegetation is composed of those species of both floras which are able to withstand extreme conditions and therefore pioneer new areas. In fact it represents the product of the struggle between the pioneer species of both floras, each striving for establishment in an arid environment.

From the nature and present distribution of the plants, both in Africa and in other continents,* the Cape flora appears to be the older and was once widespread over the southern sub-continent; in particular *fynbos* probably covered those areas characterized by tropical grassland and savanna today. Later the plants of this flora were ousted by the grasses and trees of tropical origin spreading southwards along the eastern coastal region and thence inland. In particular the tropical grasses forming a tangled mat over the surface replaced the *fynbos* which was pushed back into the winter rainfall area, where the conditions were less favourable for grasses. The process was a very gradual one extending over hundreds of thousands of years. It resulted in the development of vegetation formations which represented the climaxes under the climatic and edaphic conditions prevailing in the different regions and provided a stable cover to the surface so long as those conditions remained undisturbed.

Since man has appeared on the scene, however, he has disturbed the balance and brought about dramatic changes in the vegetative cover. By burning and overgrazing the veld he has thrown back the succession, caused the recession of the Tropical flora and permitted the eastward spread of *fynbos* and Karoo scrub. In Natal and the eastern Cape, forest and scrub forest have given way to sour grassveld on the wetter plateau slopes and to bushveld and thornveld in the drier valleys. In the southern Cape, forest and mixed grassveld have been replaced by *fynbos* and, in the south-eastern Cape and on the Highveld, Karoo scrub has advanced into areas formerly occupied by sweet grassveld. In the Karoo succulent

* The Proteaceae, the most important members of the Cape macchia and forest are found elsewhere mainly in Australia, whose flora is considered to be ancient. A few species of the Proteaceae are found in Brazil.

forms have gained at the expense of shrubs and, where the destruction of the vegetative cover has been followed by erosion, desert conditions have resulted. The *fynbos* of the southern Cape and the thornveld and sour grassveld of the eastern marginal belt thus do not appear to be climax vegetation types but successional stages produced by man's misuse of the land.

Against this background the major vegetation types will be considered.

Tropical Forest Types

For the most part the eastern marginal lands carry savanna types of vegetation and only scattered patches of forest are to be found. The yearly rainfall, 35 to 60 inches, is adequate for tree growth but the winter drought, which is alleviated only at high altitudes, where mist is frequent, and by close proximity to the sea, restricts plant life to those forms able to withstand or overcome the deficiency of surface water at this season. Nevertheless several kinds of forest vegetation occur, their distribution depending on both climatic and edaphic factors.

The muddy coastal flats north of Durban are occupied by mangroves (Plate 12), characterized by the species *Avicennia officinalis* Linn., *Rhizophora mucronata* Lam. and *Brugueira gymnorhiza* Lam., whereas the dunes which parallel the coast carry a forest growth which, under the influence of off-sea winds, is stunted and gnarled (Plate 14); under the consistently warm humid conditions the dominant trees are of tropical origin – the 'red milkwood' (*Mimusops caffra* E. Mey.), *Euclea natalensis* A.DC. and *Canthium obovatum* Klotzsch – and are usually bound together by numerous creepers; near the sea xerophytic shrubs such as *Metalasia muricata* D. Don. and *Passerina rigida* Wikstr. occupy the partially stabilized dunes and creeping plants like *Ipomoea pes-caprae* Roth., *Sporobolus virginicus* Kunth. and *Scaevola thunbergii* Eckl & Zeyh take hold on the shifting sands (Plate 13).

These littoral vegetation types are succeeded inland by the typical subtropical coastal forest (Plate 15), which, occupying a belt only a few miles wide, is composed of several tree layers bound together by a dense tangled growth of shrubs, lianes and creepers. The dominant trees – the 'umzimbeet' (*Millettia caffra* Meissn.), and *Protorhus longifolia* Engl. – are evergreen and of short stature (15 to 30 feet), but there are some large trees, e.g. *Ficus natalensis* Hochst, which shed their leaves during the dry season. The Water Berry (*Syzigium cordatum* Hochst), the wild banana (*Strelitzia nicolai* Regel & C. Koch.), *Croton sylvaticus* Hochst, and species of *Cussonia* are common. Today, due to the widespread clearing of the land for sugar cane estates and repeated wood-cutting for fuel in the sugar mills, little forest remains. In many places it has been replaced by scrubby thornveld in which the intermixture of grasses, bush clumps and patches of trees indicates its successional nature to forest. Both tall and short grasses – tall forms of redgrass (*Themeda triandra* Forsk.), the finger grasses (*Digitaria* spp.), and *Hyparrhenia* spp. and short growing species of *Tristachya*, *Heteropogon*, *Paspalum*, *Andropogon*, *Eragrostis* and *Setaria* – are present; if

heavily grazed, however, they give way to the undesirable Ngongoni (*Aristida junciformis*), and if lightly used the scrub increases. Grazing management is therefore difficult and the land is better planted to exotic pasture grasses, fodder and cash crops.

North of the Tugela river, where sandy soils overlie the badly drained coastal plain, the typical sub-tropical coastal forest gives way to the Zululand palm veld. Here patches of tangled jungle, characterized by palms, notably the wild date (*Phoenix reclinata* Jacq. Fragm.), and Ilala (*Hyphaene crinita* Gaertn.), and wild banana and many lianes are dotted about the scrubby thornveld. In ill-drained areas the trees adopt the habit of underground shrubs sending up numerous shoots from the ground to a height of a few feet; in swampy places they are absent altogether, the vegetation consisting of open grassland studded with Ilala palms.

South of Durban the composition of the coastal forest changes with the cooler and drier climatic conditions. The lower temperatures favour the occurrence of trees of temperate origin – yellowwoods (*Podocarpus* spp.), appearing on the higher parts of the Pondoland coastal plateau – and the lower rainfall is largely responsible for the dominance of xerophytic trees and scrambler shrubs in the coastal forest between Peddie and Alexandria.

Temperate Evergreen Forests

Where the rainfall is evenly distributed throughout the year, as in the southern Cape, or the winter drought is mitigated by high relative humidities, as on the higher slopes of the Great Escarpment, where mist is frequent, true timber forests are found. Such forests formerly covered large stretches of country, from the Cape Peninsula to the northern Transvaal, but they have suffered severely at the hand of man and today only relics, which now enjoy State protection, remain. The most extensive of these occur in the neighbourhood of Knysna and George, on the Elandsberg and Amatola mountains, near Kingwilliamstown and Port St Johns, in the Nkandhla area of Zululand (Plate 21), and in the Woodbush mountains of the north-eastern Transvaal.

In all areas the forests show structural similarities (Plate 16); they comprise two layers of trees of which the upper one is discontinuous and therefore presents an irregular skyline, a somewhat patchy shrub layer, numerous lianes, which, however, belong to few species, and an abundance of epiphytes. Some of the tallest trees attain 150 feet but the average height of the canopy is between 30 and 70 feet. The forests are essentially evergreen but towards the north-east, as the winter drought becomes more marked some deciduous trees come in. The leaves of most trees are simple, dark green and highly polished on the upper side; a few are wax-covered. Towards the north, however, some species possess thin or compound leaves. Generally speaking the forests are dense; little light gets through to the lower layers and in many places the ground vegetation is made up almost entirely of ferns (Plate 17). The most conspicuous components of the

forests are the coniferous 'yellowwoods' (*Podocarpus* spp.), which frequently attain a height of 100 to 150 feet and yield a timber valuable for structural purposes. Associated with them is a great variety of broad-leaved evergreen trees; these increase in number of species towards the north and at the same time become more tropical in character. Most important among them are the 'black ironwood' (*Olea laurifolia* Lam.), the 'Cape Beech' (*Myrsine melanophleos* R. Br.), the 'assegai bos' (*Curtisia faginea* Ait, Hort. Kew.), the 'stinkwood' (*Ocotea bullata* E. Mey.), a very valuable furniture wood, the 'sneezewood' (*Ptaeroxylon obliquum* Radlk.), the 'white ironwood' (*Toddalea lanceolata* Lam.), and the 'kamassi' (*Gonioma kamassi* E. Mey.). At Knysna *Trichocladus* sp. is the characteristic forest shrub but where there are openings in the canopy and at the forest margins *Plumago capensis* Willd. and *Tecomaria capensis* Spach. abound. The ground layer shows a transition from one dominated by ferns in the south to one characterized by geophytes and bulbous forms where the drought is more marked in the north. Here members of the Acanthaceae are prominent.

In favourable localities at altitudes above 4,700 feet in the northern and north-eastern Transvaal montane forests occur. On the lower slopes the trees possess leaves of larger size and lighter colour than those of the temperate forests in the south, but at 5,000 feet, near the upper limit of the forest, which coincides with the likelihood of frost, 'yellowwoods' and other members of the Knysna forest come in. These last outposts of the forest vegetation have certain affinities with the mountain forests of Rhodesia and the montane rain forests of Central Africa. In a different category are the remnants of the 'cedar' woods composed of *Widdringtonia juniperoides* Endl., which dot the Cedarberg in the south-western Cape. They are more akin to the Mediterranean vegetation types.

Sclerophyllous Bush

Largely because of a winter rainfall regime, the vegetation of the south-western Cape is different from that found elsewhere in the country. The hot dry summer is a season of dormancy while the autumn and spring are the periods of most active growth. Those plants able to thrive fall into two categories: those able to go through their vegetative cycle during the winter months, when temperatures average between 50° and 55° F., and protect themselves against the summer drought and those able to complete their life cycle within the few weeks of spring, when the soil is still moist and the rising temperatures favourable for active growth. In the former category are a number of evergreen shrubs whose hard leathery leaves or hairy leaves enable them to withstand the summer drought, in the latter plants with underground storage organs such as bulbs and tubers. Hence the vegetation consists of sclerophyllous bush in which shrubs and undershrubs predominate and bulbous and tuberous plants form the ground layer. Grasses are scantily represented but reed-like tufted plants belonging to the Restionaceae abound.

The typical sclerophyllous bush occurs where the rainfall averages between 20 and 30 inches. Here it is relatively dense; it consists of an upper storey of large bushes, mainly Proteaceae (Plate 19), attaining a height of 5 to 8 feet, with, in a few localities, stands of silver trees (*Leucadendron argenteum* R. Br.; below is a dense layer of small shrubs with thin flexible stems and small heathlike leaves, and many plants belonging to the families Compositeae and Ericaceae; the ground flora consists of small woody plants, herbs and geophytes; plants belonging to the Restionaceae are often abundant. The height, density and floristic composition of the several layers vary from place to place with differences in the climatic and edaphic conditions, but the structure and life form are remarkably constant. Thus on the lower mountain slopes, where the rainfall is heavier and low clouds and mist deposit additional moisture, the vegetation is higher; here shrubs like *Leucadendron* spp. and *Cliffortia* spp. with only slightly leathery leaves, the taller species of *Erica* and *Berzelia* spp. are common (Plate 18). The vegetation is actually most luxuriant about half-way up the south-east facing slopes which derive most benefit from the clouds associated with the summer south-easterly winds and which are otherwise relatively sheltered. Above 3,000 feet, however, the larger bushes are confined to the more sheltered places and small heaths and species of Restionaceae predominate; in very exposed places prostrate forms are evident. In the drier areas the vegetation is more open and less distinctly layered. Small bushes with hard flat leaves dominate and there are generally few plants with ericoid leaves, although locally *Passerina* spp. may be important. Succulents, particularly *Mesembryanthemum* spp., come in and annuals are common. On seasonally moist flats, reed-like plants of the Restionaceae are abundant while *Mesembryanthemums* with a creeping habit take hold on the coastal dunes. Vleis are characterized by *Phragmites* and *Typha* spp. while the slow-flowing streams are usually choked with the 'palmiet' (*Prionium serratum* Buchen.). This together with a great variety of Restionaceae gives a characteristic brown colour to the stream water.

Whether the sclerophyllous bush represents a climax vegetation is doubtful. It is known that the more sheltered kloofs on the eastern and southern sides of Table Mountain formerly carried evergreen forests containing 'yellowwoods' (*Podocarpus* spp.), 'ironwoods' (*Olea* spp.), 'stinkwood' (*Ocotea bullata*), 'mountain hard pear' or 'rooi hout' (*Olinia cymosa* Thunb.), and 'red alder' or 'rooi els' (*Cunonia capensis* Linn.), and that these have been cleared by the axe and recurrent fires. The shrub vegetation, because of its resinous nature, is easily fired, especially towards the end of the dry season. Firing has gone on for centuries, sometimes intentionally in order to improve the grazing or afford dry wood for fuel, sometimes spontaneously. It has undoubtedly retarded the normal succession and it may well have contributed to the abundance of bulbous plants which would be least affected. It seems doubtful, however, whether a forest vegetation could develop under the present rainfall regime except on the mountain slopes.

Tropical Bush and Savanna

The greater part of the hot dry country lying between the foot of the Drakensberg Escarpment and the Lebombo mountains and between the Bankeveld and the Limpopo river carries a parkland type of vegetation in which the upper stratum consists of typically umbrella-shaped trees of low stature and the undergrowth is dominated by tall grasses which die down and become dormant during the winter

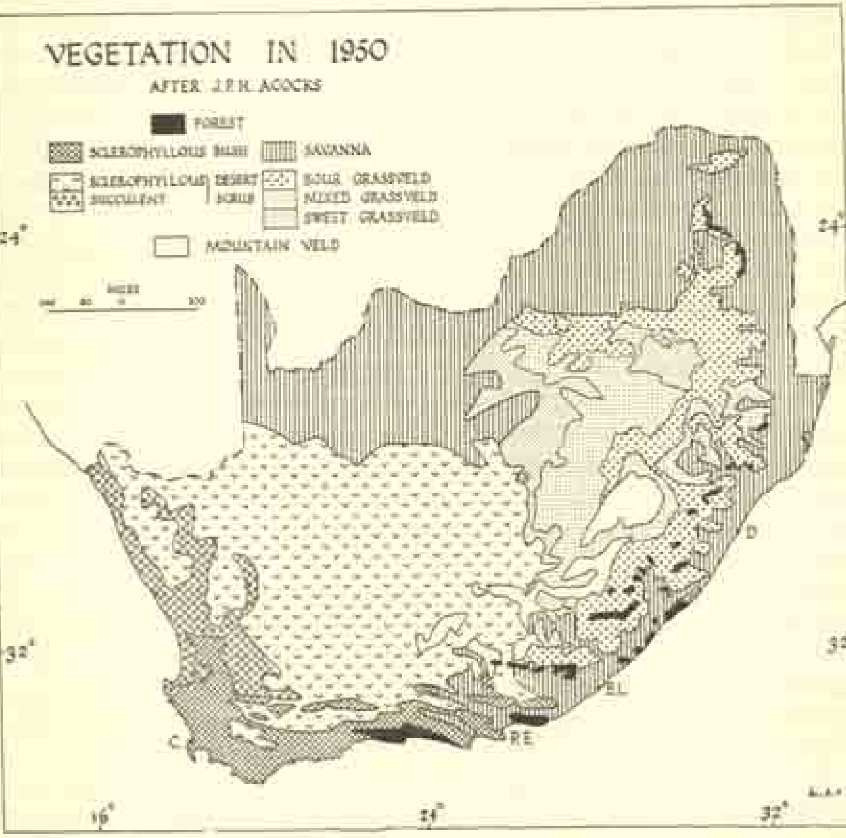


Fig. 38. The distribution of the major vegetation types of the Union of South Africa in 1950.

(Courtesy of *Geography*.)

(Plate 23). Trees both of evergreen and deciduous habit occur; most of them have a single trunk bare of branches for some distance above the ground, and are characterized by such devices for combatting the strong insolation and drought as mobile, pinnate leaves, the reduction of the leaves to thorns, deep rooting habits and water storing organs. The status of this vegetation is open to question. There seems little doubt that, except in the eastern coastal belt, the severity of the

drought coupled with strong insolation by day and the liability to light frosts at night, particularly in inland localities, during winter limit tree growth at the present day; only those trees adapted to withstand such conditions are able to survive while they finally drop out at about 4,500 feet where the frequency of frost brings about the change from savanna to grassveld. The savanna might therefore appear as a transitional type of vegetation between the true forests and the pure grasslands, its limits determined by incidence of drought and freedom from frequent frost. But the form of the trees, their distribution, the nature of the associated grasses and the changes in the character of the vegetation when undisturbed for several years indicate that fire and grazing by domestic animals have played major roles in keeping open the growth and preventing the formation of dense bush which would appear to be the natural climax.

There are other factors to be considered too. In the Lowveld and Bushveld the savanna occupies remarkably level country – the peneplaned or pediplaned surfaces of the Victoria Falls and African cycles. In the eastern marginal lands sour grassveld covers the flat-topped plateau spurs (Plates 10 and 20), thornveld occupies the flat-floored and enclosed river basins (Plate 22), e.g. the Ladysmith basin of the Tugela river, the valley of the Great Kei river, and forest is restricted to the sloping ground, particularly the escarpments and valley sides (Plates 10 and 20). The level surfaces, all remnants of peneplains or pediplains, are characterized by poor drainage and soils with a ferruginous hardpan. Such conditions are unfavourable for forest trees but tolerable for savanna trees and grasses. Hence they are occupied by some form of savanna until dissection in a new erosion cycle ameliorates the conditions sufficiently to allow the extension of forests, usually along the valley sides of headward eroding streams. Since the encroachment of new erosion cycles into the old peneplains or pediplains is proceeding most rapidly in the eastern coastal belt (see ch. 1, p. 18), the vegetation is, as might be expected, most varied and most susceptible to change there. There also the newly established forest trees and tropical grasses are most easily disturbed by fire and subsequent overgrazing and the succession thrown back to savanna, usually of impoverished form.

The distribution of the savanna vegetation is thus governed by climatic and edaphic factors, by successional changes associated with the geomorphological evolution of the landscape and by man's interference.

Today savanna covers a very large tract of country spanning 7 degrees of latitude and ranging from 500 to 4,500 feet in elevation and, as is to be expected, there are marked variations in its character and composition consequent upon variations in the climatic and edaphic conditions and in the treatment it has received. In the Lowveld 'knoppiesdoring' (*Acacia nigrescens* Oliver), and 'maroola' (*Sclerocarya caffra* Sond.), trees dot a grassveld dominated by redgrass (*Themeda triandra*) (Plate 23), which is sweet on the heavier soils derived from volcanic material but tends to be sour on the sandy soils, especially those derived from granite. Towards the east (Plate 24), where the rainfall drops below

20 inches, the finger grasses (*Digitaria* spp.) replace *Themeda* spp., the acacias increase in number and are joined by species of *Combretum*, arborescent Euphorbias and an occasional 'mopani' tree which in favoured frost-free localities may attain a stature of 15 to 25 feet; in the low-lying hot Limpopo valley, receiving only 15 inches of rain per annum, the mopani veld, characterized by a short dense growth of shrubby *Copaifera mopane* J. Kirk., seldom attaining more than 10 feet and more usually only 4 feet, associated with an occasional water storing 'baobab' (*Adansonia digitata* Linn.), and sparse tufted grasses, is fully developed. By contrast the moister country of the southern Soutpansberg, where the yearly rainfall exceeds 30 inches, carries a varied assemblage of temperate and tropical trees of both hygrophyllous and sclerophyllous form, some with rounded, some with flat crowns, and shows a remarkable emulsion of forest and parkland according to aspect, while everywhere the water courses are revealed by a corridor of trees – the 'fever tree' (*Acacia xanthophloea* Benth.), the 'sausage tree' (*Kigelia pinnata* DC.), and the 'Cape mahogany' (*Trichilia emetica* Vahl.) – linked together with lianes.

Compared with the Lowveld the savanna of the Bushveld basin (Plate 25) is simpler and more open, the trees are deciduous, smaller and more uniform in size, the grass layer is shorter and the sward more continuous, characteristics considered to be a reflection of the cooler conditions prevailing there. Edaphic factors are, however, largely responsible for important local variations, almost pure grassland consisting of species of *Setaria*, *Themeda*, *Digitaria* and *Panicum* occurring on the soils derived from basalt on the Springbok Flats, whereas an almost impenetrable scrub dominated by the wild sering (*Burkea afrikana* Hook), and the vaalboom (*Terminalia sericea* Burch), reigns over the poor sands derived from quartzite, sandstone and granite. It should be remembered, however, that in places the natural vegetation of the Springbok Flats has been disturbed by cultivation and that elsewhere overgrazing has promoted the establishment of *Acacia* thickets. The mountains of the Bushveld and the Waterberg plateau, which receive a somewhat higher rainfall (over 25 inches), but are characterized by infertile shallow soils today carry an open savanna vegetation in which tall 'boekenhout' (*Faurea saligna* Hart), trees are scattered in a tall, wiry, sour grassveld; possibly sweet redgrass was formerly abundant and has been reduced by burning and selective grazing, but the poor soils are generally unfavourable for the more succulent grasses today.

The thornveld which covers the greater part of the Kalahari, where the annual rainfall varies from 5 inches in the west to 20 inches in the east, constitutes a more open type of savanna (Plate 26). It consists of an admixture of tall, tufted and widely spaced grasses together with thorny *Acacia* trees and bushes. It shows, however, marked areal differences. Thus whereas true thornveld has developed where deep loose sand covers calcareous tufa, a shrub bushveld occurs on the thin stony soils which overlie calcareous tufa and dolomite on the Kaap plateau and banded ironstone and lava on the Asbestos and Kuruman hills and the Langeberge. The first mentioned type is dominated by the camelthorn (*Acacia*

giraffae Willd.), accompanied by the vaalkameel (*Acacia haematoxylon* Willd.), on the alkaline soils of the drier west; between the trees tall tufted grasses form an incomplete cover, *Themeda triandra* and *Cymbopogon plurinodis* Stapf. occurring along with *Eragrostis superba* Peyr. in the east but giving way to various species of *Aristida*, particularly the tall and short bushman grass, and *Eragrostis* spp. – the so-called white grasses – with increasing aridity. The character and composition of the shrub bushveld varies greatly but generally speaking is dominated by species of the shrub *Tarchonanthus* which affords succulent fodder; on flats and around pans such grasses as *Themeda* spp. and *Digitaria* spp. provide sweet grazing but on the stony outcrops only wiry species of *Aristida* and *Eragrostis* are found, along with invaders from the Karoo.

Grassland

At altitudes exceeding 4,500 feet on the Highveld plateau, where marked drought, severe night frosts and considerable diurnal variations of temperature in winter are inimical to tree growth, the natural climax vegetation is true grassland. Two main types are recognized – the short grassveld or sweetveld in the east (Plate 53) and the mixed grassveld, less pure in composition, towards the drier west. Their eastern and northern limits coincide with the Drakensberg Escarpment and Bankeveld respectively, beyond which freedom from severe winter frost permits the growth of trees of tropical origin; westwards the increasing aridity is associated with the incoming of thorn bushes and Karoo shrubs until, where the yearly rainfall is normally less than 15 inches, the grassveld finally grades into thornveld in the north and karroid shrub in the south. Formerly tall grassveld or sourveld, occurring in areas subject only to light frost, was included in the grassland category but it is now believed that this is a seral type of vegetation, which is maintained by grazing and periodic firing and would naturally succeed to bush, thornveld or forest if left undisturbed.

Over the Highveld the character and composition of the grassveld varies with climatic and edaphic conditions. Most widespread is a sward dominated by redgrass (*Themeda triandra*) (Plate 49), and *Cymbopogon plurinodis*, which covers most of the country between 5,000 and 6,000 feet. Other grasses, particularly species of *Eragrostis* and *Setaria*, are associated with the dominants while a variety of herbaceous perennials, including many geophytes, and numerous bulbous plants make up the ground layer. Usually the grasses, which normally attain a height of 2 to 3 feet at the flowering stage, grow in clumps and have perennating shoots on or just above the surface of the soil. Only rarely do they form a continuous turf and consequently any disturbance of the cover is likely to throw back the succession and bring soil erosion in its train. On fine-grained soils, particularly on 'black turf' derived from dolerite, redgrass abounds almost to the exclusion of all others; it is shorter than on more open soils and it flowers less freely, providing a sweet veld which retains its succulence in autumn when it provides good grazing. This veld formerly covered a considerable tract of country

in the Standerton and Bethal districts but much of it has now given way to cultivation. Patches occur also farther west wherever dolerite underlies the surface. On poorer soils, particularly those of a sandy nature, the veld is of less value. Towards the Great Escarpment, where the rainfall exceeds 35 inches, *Tristachya hispida* K. Schum. is co-dominant with *Themeda triandra*, the grasses exceed 3 feet at the flowering stage and afford only sour grazing. Outliers of this sourveld type occur at 4,000 to 5,500 feet on the Cedarville Flats and on the sandy country around Mount Fletcher, Matatiele and Kokstad. By contrast on the dry western margins drought resistant species of *Eragrostis*, *Aristida* and *Sporobolus* together with undershrubs are associated with *Themeda triandra* and *Cymbopogon plurinodis*. The growth may be as high in summer as in the central areas, but it is less luxuriant, the tufts are closer and the leaves harsher. With increasing aridity the cover becomes sparser until the vegetation passes to that of thornveld and Karoo shrub.

Alpine Veld

At high altitudes along the Great Escarpment low winter temperatures are responsible for the occurrence of alpine veld (Plate 129). This has a remarkably uniform composition from the Drakensberg to the eastern Nieuweveld, although differences in the annual rainfall, from 25 to 75 inches according to location and aspect, cause local variations. The black turfy soils of the Drakensberg basaltic plateau (at over 6,000 feet elevation) carry a short dense alpine grassveld, varying from sweet to mixed and dominated by *Themeda triandra*. A number of low-growing tussock grasses, particularly *Festuca* spp., are also present as well as *Danthonia disticha* Nees, which is particularly common on shallow soils, and plants belonging to the *fynbos* – *Passerina montana* Thoday, several species of *Erica* and *Cliffortia* – and karroid false fynbos, most prominent among them being *Chrysocoma* and *Helichrysum*. Wherever the veld has been disturbed by overgrazing or has suffered erosion *Danthonia disticha*, and the *fynbos* and karroid elements increase. They also become more prominent westwards until *Danthonia* mountain veld covers the tops of the higher mountains of the Karoo and finally gives way, near Beaufort West, to mountain renosterveld, a marginal community between the Karoo on the dry side and the sclerophyll on the wetter, which clothes the upper slopes of the Nieuwveld range, the Roggeveld mountains and the Kamiesberg.

False Grassveld

The vegetation covering the Bankeveld, the Witwatersrand and Gatsrand, the Pietersburg plateau and the slopes of the Drakensberg at an elevation of between 3,000 and 4,500 feet consists of a sour grassveld composed of grasses typical of both the true grasslands and the Bushveld, with Protea spp. and Acacia spp., on rocky hills and ridges and traces of temperate or transitional forest in sheltered valleys. The distribution of this type of vegetation appears to be related to

edaphic conditions, occurring mainly where poor, acid, sandy soils, derived mainly from quartzite and granite, prevail. *Tristachya hispida* and *Eragrostis chalcantha* Trin. are usually among the dominant grasses and give rise to a wiry veld, very sour and unpalatable in winter. Where more fertile soil occurs as on dolerite outcrops in Natal, *Themeda triandra* and *Hyparrhenia hirta* Stapf. come in and provide sweet grazing. The distribution of trees and shrubs, however, indicates that the vegetation is seral to scrub forest, the poverty of the soils no doubt playing a part, along with overgrazing and fire, in holding back the succession and permitting the survival of only the more wiry pioneer grasses.

Karoo Bush and Desert Shrub

Where the annual rainfall averages less than 15 inches and the diurnal variation of temperature is such that excessively hot days (with maxima over 100° F. or even 110° F.), are followed by cold nights (with the minima below 35° F. in winter), the vegetation consists of stunted woody or fleshy shrubs and succulent plants widely spaced in bare soil. On a broad basis there is a distinction between the desert shrub of the area receiving between 5 and 15 inches of rain annually, the succulent desert of the Namaqualand coastal belt where the rainfall, averaging less than 5 inches, occurs in winter, and the succulent bush of the enclosed valleys of the summer rainfall belt of the south-eastern marginal lands. But within each there are many different plant associations, for the whole area, located between the realms of the Cape and Tropical floras, is one of intense competition between pioneer species and experiences both plant migrations and successional changes from both directions. These have been aided by the east-west orientation of the Cape ranges in the south and of the Orange river valley in the north, all acting as natural avenues of plant spread. The plant communities are most varied in their vicinity. Further in historic times much change has occurred as a result of man's interference associated with grazing domestic animals.

The shallow rocky soils of the plateau country of the upper Karoo carry a vegetation of 'Karoo bushes' (Plate 27), dominated by *Pentzia* spp. and *Chrysocoma tenuifolia* Berg. They generally attain a height of some 3 to 12 inches and are characterized by a dual root system – with the main roots penetrating to great depths and lateral ones spreading out near the surface – by leaf-bearing branches fanning from the central stem just above ground level in the fashion of a shaving brush and by very small leaves – devices enabling them to take advantage of all available moisture and to withstand drought. Towards the north-west the increasing aridity is too great even for Karoo shrubs. Here on the sandy soils of the granitic plateaux the 'driedoring' (*Rhigozum trichotomum* Burch.), which attains a height of 1 to 3 feet and differs from the karoo bushes in having a loose erect branching habit and small flat hard adpressed leaves, assumes dominance while on the deep sands of the plains of Bushmanland and Namaqualand the 'bushman grass' (*Aristida brevifolia* Steud) covers wide areas. Where there is a high concentration of salt at the surface only succulents, especially species of

Mesembryanthemum, with *Lycium* in the drier areas, survive, while even these give way to the 'ganna veld' composed of species of *Salsola*, possessing adpressed succulent leaves, on the saline silty flats of the pans, e.g. Groot Vloer, and along river beds dry for most of the year. By contrast the 'camelthorn' (*Acacia giraffae*) is characteristic along dry river courses while the 'kokerboom' (*Aloe dichotoma* Linn.) frequently associated with the 'gifbloom' (*Euphorbia virosa* Willd.) and 'melkboom' (*Euphorbia dregeana* E. Mey.) is common in the hills.

In the south the stony plains of the Great and Little Karoo carry a sparse growth of dwarf trees and shrubs with varying amounts of grass and succulents but the richness of the flora in number of species, the distribution of these species and the changes in the character of the veld when rested suggest that before erosion followed in the train of overgrazing, shrubs and grasses covered the plains and grasses choked the vleis. Today such shrubs as species of *Pentzia* and *Eriocephalus*, associated with the more drought resistant grasses – *Eragrostis* and *Aristida* spp. occupy the Great Karoo while in the Little Karoo the typical shrub is the guarri (*Euclea undulata* Thunb.) occurring with other shrubs and numerous Mesembryanthemums. On the lower slopes of the surrounding mountains the vegetation passes to the *renosterveld* and *fynbos* in the west but to the grassy scrub in the east.

On the moister mountains to the south and west of the Upper Karoo the vegetation shows an admixture of Karoo shrubs, renosterbos and Namaqualand succulents. Generally the shrubs dominate and attain a greater height than in the Karoo, but as a result of persistent overgrazing particularly at lower levels many have adopted a dense, woody, tangled 'cushion habit' with the leaves inside the cushion.

To the west true desert characterizes the area between the Great Escarpment and the coast. Here in a belt varying in width from 10 to 80 miles and extending tongue-like up to the Orange river valley and receiving rainfall only at intervals of several years, the few plants that do occur are mainly stem succulents widely spaced from one another. Nevertheless there are marked variations in the plant communities. Over the dome-shaped granite hills of the escarpment slope the vegetation is characterized by the 'kokerboom' (*Aloe dichotoma*), 'melkboom' (*Euphorbia dregeana*) and the 'Bushmans Candle' (*Sarcocaulon Burmanii* Sweet) along with many Mesembryanthemum spp. and other succulent plants and numerous annual Compositae which burst into flower after rain and produce a riot of brilliant colours. By contrast the gravel plains may be destitute of plants for many miles, carrying only a scanty growth of wiry grasses or an occasional Bushmans Candle; in the north near Walvis Bay the extraordinary plant the 'tumboa' *Welwitschia mirabilis* occurs. The dunes carry only isolated tufts of wiry grasses, while a few succulent plants, able to tolerate saline conditions, occur along the coast. However, in places a semi-succulent scrub occurs near the coast and displays certain affinities with the *fynbos*, while the camelthorn and other acacias frequently follow the river valleys.

In the enclosed valleys of the Sundays, Great Fish and various smaller rivers draining to the coast in the south-eastern Cape, a form of succulent bush made up very largely of Euphorbia spp., Aloe spp. and Portulacaria spp. (Plate 28), and attaining a height of 6 to 8 feet is found. Possibly these may represent either outliers of the Karoo vegetation or members of the Tropical flora which have become adapted to the arid conditions. Perhaps they are best looked on, as was suggested several years ago by J. W. Bews, as forest vegetation in a Karoo climate.

Today, as in the past, the natural vegetation is undergoing change. Much has been cleared to prepare the way for crops, much has been interfered with during attempts to increase the useful grazing plants. At the moment good grassland is becoming invaded by thorn scrub while nutritious Karoo bushes are giving way to poisonous succulents as a result of uncontrolled grazing. Unless due attention is devoted to the dynamic aspects of vegetational change and succession it seems likely that within a short time much useful grazing will have been lost and the desert greatly enlarged.

BIBLIOGRAPHY

1. R. S. ADAMSON. *The Vegetation of South Africa.* British Empire Vegetation Committee, Kew. 1938.
2. I. B. POLE-EVANS. *A Vegetation Map of South Africa.* Bot. Surv. of S.A., Mem. No. 15, 1936.
3. J. P. H. ACOCKS. *Veld Types of South Africa.* Bot. Surv. of S.A., Mem. No. 28, 1953.
4. J. F. V. PHILLIPS. 'Fire. Its influence on biotic communities and physical factors in South and East Africa'. *S.A.J.Sc.*, Vol. XXVII, 1930.
5. J. W. BEWS. 'The vegetation of Natal'. *Ann. Nat. Mus.*, No. 2, 1912, p. 293.
6. R. D. AITKEN and G. W. GALE. *Botanical Survey of Natal and Zululand.* Bot. Surv. of S.A., Mem. No. 2, 1921.
7. J. W. BEWS. 'An oecological survey of the Midlands of Natal with special reference to Pietermaritzburg district'. *Ann. Nat. Mus.*, No. 2, 1913, p. 485.
8. R. A. DYER. *The Vegetation of the divisions of Albany and Bathurst.* Bot. Surv. of S.A., Mem. No. 17, 1937.
9. R. STORY. *Botanical Survey of the Keiskammahoek District.* Bot. Surv. of S.A., Mem. No. 27, 1952.
10. J. F. V. PHILLIPS. *Forest Succession and Ecology in the Knysna Region.* Bot. Surv. of S.A., Mem. No. 14, 1931.
11. O. WEST. *Vegetation of Weenan County, Natal.* Bot. Surv. of S.A., Mem. No. 23, 1951.
12. J. W. BEWS. 'Plant succession in the Thornveld', *S.A.J.Sc.*, Vol. XIV, 1917, p. 153.
13. J. W. BEWS. *The Grasses and Grasslands of South Africa.* Pietermaritzburg, 1918.

14. S. M. MURRAY and P. GLOVER. 'A preliminary study of the root development of certain South African Highveld grasses'. *J.S. Afr. Bot.*, Vol. I, 1935, p. 65.
15. J. F. V. PHILLIPS. 'Some problems presented by South African grasses and grass communities'. *J.S. Afr. Bot.*, Vol. I, 1935, p. 47.
16. G. POTTS. 'The plant succession in the Orange Free State and the need for maintaining a covering of vegetation'. *S.A.J.Sc.*, Vol. XX, 1923, p. 196.
17. J. W. ROWLAND. 'Notes on the study of plant succession in relation to grazing'. *S.A.J.Sc.*, Vol. XXX, 1933, p. 307.
18. J. W. BEWS. 'The plant ecology of the Drakensberg Range'. *Ann. Nat. Mus.*, Vol. III, 1917, p. 511.
19. R. R. STAPLES and W. K. HUDSON. *An Ecological Survey of the Mountain Area of Basutoland*, 1938.

4

Soils

From the agricultural standpoint the structure and texture of the soil and its content of mineral and organic matter are of fundamental importance; the former as it affects ease of working, aeration and drainage, capacity to absorb and retain water, power to resist erosion; the latter as it provides plant nutrients.

The nature and composition of the soil are the result of certain soil forming processes, dependent very largely on climatic conditions, acting over a variety of rocks and incorporating the decaying matter of varying types of vegetation. The variety of soils is enormous but the processes are limited in number and each generally results in the development of a characteristic vertical section or soil profile. This normally comprises three horizons, the upper or A horizon from which mineral and organic matter is removed by downward percolating water, the B horizon below, in which the leached material is deposited, and the C horizon of partially decomposed parent rock. Largely as a result of the work of Russian and American pedologists it is usual to classify the great variety of individual soils into a relatively small number of major groups on the basis of the special characteristics of their profile. This classification embraces only mature soils and in South Africa the long continued uplift of the sub-continent and the great elevation of the plateau have allowed little opportunity for soil formation so that most of the soils are immature or even skeletal. Thus while major soil zones based on soil forming processes largely dictated by climatic conditions may be recognized, the nature of the parent material, usually derived from the underlying geological formation, frequently determines the soil type. Further in areas of uneven relief, slope and drainage are important and it is usual to find a succession of different soils from the hill-top to the valley, repeated again and again. Thus the soil catena – as this sequence is now called – must be considered.

In the first place four major soil zones (Fig. 39) may be recognized, each characterized by one dominant soil forming process which is determined very largely by the climatic regime – one of unleached soils in areas of scanty rainfall, one of thin immature soils in the winter rainfall belt, one of podsolic soils where the temperatures are moderate and another of lateritic soils where the temperatures are high throughout the year in the summer rainfall areas.

In the north and west where the rainfall is below 15 inches and temperatures are subject to great diurnal and seasonal variation, soil formation is conditioned by the fact that evaporation exceeds precipitation (see Fig. 36). Chemical decomposition is not possible and the parent material is broken up solely by mechanical agents; the downward leaching of soluble salts is negligible, but the reverse movement leading to their precipitation near the surface, is more likely. The soils are alkaline, poorly developed and, apart from a lime accretion layer, are not differentiated into horizons.[1] In the winter rainfall area of the Cape soil formation is retarded in summer by drought, and in winter, when moisture is present, by temperatures that are low for chemical activity but not sufficiently low for frost action to become important. Soils therefore form slowly and are generally thin and immature.[2] Soil forming processes are more active over the summer rainfall area. Over the Highveld and in the eastern coastal lands, soils have formed under conditions which favour intermittent podsolization. In summer the combination of heavy rainfall and moderate temperature results in the leaching of the more soluble mineral constituents; the winter drought calls a halt to the process but the temperatures are not sufficiently low to bring organic decomposition to a standstill. Under a vegetative cover of temperate grassland or broad-leafed forest there is no accumulation of raw humus, such as occurs under a coniferous forest cover in areas subject to continuous leaching under low temperature conditions; the soils formed under the South African conditions are podsolic, but not true podsols. Farther north and north-east, where heavy summer rainfall is experienced and temperatures are high throughout the year, laterization is the dominant process. All but the aluminium and iron compounds are removed by leaching but over most of the area the winter drought period prevents the ultimate development of laterite and the soils are lateritic.

Each of these zones corresponds in a general way with a vegetational zone; thus desert shrub covers the area characterized by desert soils, sclerophyllous bush prevails in the winter rainfall area, grassland where the podsolic soils occur and evergreen and deciduous tree and thorn forest and savanna where laterization is dominant. Beyond these generalizations lie important differences caused by parent material and relief and drainage conditions.

Soils of the Arid Zone

Over the desert region the climatic influence is so strong that similar soils have developed over very varied geological formations – ranging in age from Primitive to Karoo and in character from quartzites and schists to shales and limestones. The soils all have an alkaline reaction, are thin and show no differentiation into horizons. Over much of the area they consist of light brown sandy loams, which become denser with depth and are underlain by a hard layer cemented by either calcareous or siliceous material and known respectively as calcrete or silcrete. Towards the Kalahari, however, the soils are more sandy while around Sutherland, Williston, and Fraserburg, where the relief is more broken, very little soil

has accumulated; in the extreme west only thin patches of sandy material occur below the desert pavement. In the north where wind-blown Kalahari sand covers the ancient rocks, the soil consists of a reddish brown friable sand, overlying a dirty bouldery limestone. Here rainwater percolating rapidly through the sand has dissolved out the lime from the ancient rocks below and subsequently, on being drawn towards the surface by intense evaporation, has precipitated it as a layer of limestone. The soils are rich in mineral plant nutrients and although deficient in organic matter – due to the scanty vegetative cover – might with irrigation sustain crop production. The hard limestone band, however, impedes efficient drainage without which the application of irrigation water leads to a concentration of salts near the surface and alkali troubles. In the interior Kalahari sand, in places up to 250 feet thick, mantles the surface and forms sand dunes. In the intervening troughs some silty material has accumulated and around watering places has been compacted by the trampling of animals. These soils offer no possibilities for agriculture and even the scanty vegetation has difficulty in maintaining its hold.

In the western Free State and north-eastern Cape, where the rainfall averages between 15 and 20 inches the soil profiles show the transition from semi-arid to sub-humid conditions. Here over the level plateau underlain by Karoo sandstones and shales the rainfall is sufficient to cause some leaching but alkali accumulation takes place during the long dry periods and solonetzic soils have developed. They are unique in their sharp distinction between the A and B horizons. The former comprises a porous grey sandy loam which readily breaks up under slight pressure, the latter is dark blackish-brown clay, which on drying contracts into clumps readily broken into clods. The A horizon has a slightly acid reaction and is devoid of carbonates, the B horizon is alkaline, becoming strongly alkaline with depth, and well supplied with carbonates. The more soluble mineral constituents have in fact been leached from the A horizon and deposited in the B horizon along with others drawn up from below. Soils of this description rarely occur over such extensive areas but here under predisposing climatic conditions, the geological conditions are peculiarly favourable – readily pulverized sandstone underlain by shales impregnated with alkali salts. Towards the east, where the amount of sandy material at the surface thins out and the precipitation is greater, the soils change to the Highveld Prairie type. The solonetzic soils are of very limited value for agriculture. They are excessively light and droughty and are liable to erode badly. The light sandy surface soil is readily blown by the strong winds characteristic of the area while the abrupt change from the sandy material of the A horizon to the clay of the B horizon is very conducive to gully erosion.

The Gley-like Podsolic Soil Zone

Over the eastern plateau and marginal lands of Natal and the eastern Cape Province soil-forming processes are governed by the combinations of warm days and cold nights in winter and consistently high temperatures and thunderstorm

rains in summer. The surface is generally uniform and covered with a grassland vegetation but in the coastal strip it becomes hilly and is clothed with evergreen and deciduous forest. During the dry winter no leaching of mineral or organic constituents can take place, but there is little opportunity for the accumulation of organic matter for the day temperatures are not sufficiently low to bring organic decay to a standstill and veld burning is commonly practised. In summer the high day temperatures promote rapid decomposition of organic matter, while leaching occurs sporadically, taking place during the heavy thundershowers which frequently give rise to temporary waterlogged conditions. Under this regime the characteristic soil profile comprises an A horizon of sandy loam, poor in humus and leached of the more soluble mineral constituents, overlying a B horizon of impervious mottled clay in the upper portion of which are ferruginous concretions; the latter have formed as a result of intermittent waterlogged conditions following rains, when the iron oxide compounds become highly mobile. The features of the B horizon are indicative of a gleiing process but, on the other hand, the higher percentage of lime compared with that in the A horizon is suggestive of podsolization. The soils are in fact intermediate in type. Their character changes to some extent from west to east under the influence of increasing rainfall and in the coastal belt of higher temperatures too.

The soils developed over the eastern part of the plateau have been termed the Highveld Prairie Soils. Brown in colour, they represent the nearest approach to true Prairie Earths, which in the absence of conditions conducive to the accumulation of organic matter and the formation of a layer rich in calcium carbonate are not found anywhere in Southern Africa. The Highveld Prairie soils are deeper than the other Gley-like Podsolic soils and consist mainly of fine sandy loams overlying a B horizon of clay.[3] The A horizon has been leached of the more soluble minerals but the soils, nevertheless, contain moderate amounts of potash, soda and phosphoric oxide and with good husbandry are capable of supporting a variety of crops – maize, groundnuts, teff, etc.

East of the Drakensberg heavier rainfall and higher temperatures promote greater leaching and accelerate the formation of iron concretions so that the soils of the semi-coastal belt and coastal belt differ from those of the Highveld in several respects. Generally speaking they are more sandy and poorer in plant nutrients, while, particularly in the coastal lowland, iron concretions are more abundant in the B horizon. Under cultivation these soils are highly susceptible to erosion unless special precautionary measures are adopted. Thus, while satisfactory for sugar cane plantations where care is exercised, they have become severely eroded under primitive cultural practices in the Bantu reserves.

Within each of these soil belts, intrazonal types are found locally in association with particular geological and relief conditions. Most important are the Black Clays[4, 5, 6] formed from intrusive dolerite within the Highveld Prairie soil zone. Composed of more than 60 per cent clay particles they become very sticky when wet but break up into columns and clods in dry weather. Their black colour is due

to the reduction of the iron compounds as a result of impeded drainage, not to the presence of organic matter. Indeed they lack humus. Although somewhat leached they have an only slightly acid reaction and contain appreciable quantities of soluble salts, particularly calcium. They constitute some of the best agricultural soils of the plateau. Somewhat similar black clays are found in the ill-drained areas along spruits where, however, their vulnerability to gully erosion limits their use for cultivation. Comparable intrazonal soils develop under similar conditions in the semi-coastal belt and the coastal lowland. In the transitional belt below the foothills of the Drakensberg the soils resemble the normal type for the group but possess a compact clay stratum corresponding to the C horizon, which makes them susceptible to gully erosion.

In the north-western Orange Free State the soils are transitional in character between the Kalahari sand on limestone and the Highveld Prairie type. As in the case of the former type the surface is covered with a layer of Kalahari sand, here thin, which overlies Karoo beds but the higher rainfall causes slight podsolization with the result that the soils consist of greyish-brown friable sands passing downwards to sandy loams in the B horizon and finally to an impervious clayey sand. The soluble salts have been leached from the A horizon and deposited in the B horizon. A layer of ferruginous concretions occurs in the B horizon while near the base calcium carbonate is found in pockets and veins. Under cultivation these soils start to blow wherever depleted of their humus content and special protective measures such as strip cropping and wind breaks are essential.

The Lateritic Soil Zone

Over the eastern slopes of the Drakensberg and the southern slopes of the Soutpansberg heavy precipitation, high temperatures and efficient surface and internal drainage, resulting from the generally undulating to hilly relief, favour laterization processes. When given full play these bring about the rapid and complete disintegration and decomposition of the parent rock and soil material, the release and removal of the silica, the separation and fixation of the sesquioxides in the surface horizon, and the complete mineralization and subsequent removal of the organic matter. The resulting soil is a Laterite, which shows no differentiation into horizons and consists throughout very largely of clay particles made up of oxides of aluminium and iron, the latter giving it a characteristically red colour. The bases – lime, magnesium, soda, and potash – are lacking, and there is practically no humus. However, the physical conditions are such that this occurs only over relatively small areas while elsewhere the course is incomplete and the soils have the nature of Lateritic Red Earths and Lateritic Yellow Earths, their colour depending on the iron content.

True laterites are found only over the high rolling and mountainous dolomitic country of the Drakensberg mist belt where the continuously hot damp

conditions of summer accelerate the chemical decomposition of the readily soluble parent material and excessive surface and internal drainage – due respectively to the steep slopes and to the uneven relief and the cavernous nature of the dolomite – hastens the removal of the weathered products. Only clay particles and iron oxide remain and under the dry conditions of winter the latter is dehydrated and retained in the soil to give it its characteristic red colour. The soils are generally deep, particularly on the middle slopes; some catenary changes, however, are evident, dark brown clays with a poor structure being characteristic of the ill-drained valleys, while only thin soils have accumulated over the ridges.

On the lower slopes of the Escarpment where the rainfall is less and the parent rock, whether derived from sandstone, conglomerate or granite, contains a high proportion of quartz, the soils are less leached and more sandy. In other respects they resemble true laterites; hence their designation as Lateritic Red Earths. Within the group catenary changes are well-marked. Thus in mountainous tracts the soils are rather immature and shallow while on the undulating ridges they are deep but characterized by a pebbly layer about 12 inches thick at a depth of some 30 inches. In low-lying valleys and along spruits, where the surface drainage is poor, vlei soils develop, while in places, near spruits overgrown with an aquatic vegetation, an indurated ferruginous hardpan or bog iron ore occurs in the subsoil.

The Lateritic Yellow Earths are more patchy in their distribution, occurring mainly in the belt extending from the Midlands to the eastern plateau slopes of Natal, but also at lower elevations in the foothills of the Drakensberg in the eastern Cape and at higher altitudes on the scarp and crest of the Transvaal Drakensberg. They develop in areas experiencing lower winter temperatures than the Red Earths, in fact where the temperatures during the dry season are too low for the dehydration of the hydroxides of iron; consequently the iron content of these soils is lower than that of the Red Earths, and hence they have a yellow colour. In the Transvaal they develop at higher altitudes than the Red Earths and in Natal and the Cape where the slopes are very steep and the drainage excessive they intrude into the Podsolic zone. Generally speaking they are more sandy and of coarser texture then Red Earths.

Despite their high clay content the lateritic soils possess an excellent crumb structure with good water-absorbing and water-retaining properties; this is due largely to the free alumina and the oxides of iron which cement the material into aggregates which are not easily puddled. Under a vegetative cover these soils do not normally erode but under intensive cultural operations the sub-soil is easily compacted and erosion naturally follows. Contour ploughing and careful land management are essential for sound agricultural development. Moreover the lateritic soils present a number of problems when used for crop production. In the first place the same factors which remove the mineral and organic constituents from the parent material also remove chemical and organic fertilizers applied to

the soil. Secondly the soils are very low in bases and when chemical fertilizers are applied the minerals enter into base exchange relationships and become unavailable to plants. Most serious is the fixation of phosphoric-oxide which readily combines with the alumina and iron oxides.

Over the greater part of the country lying between the Gley-like Podsolic

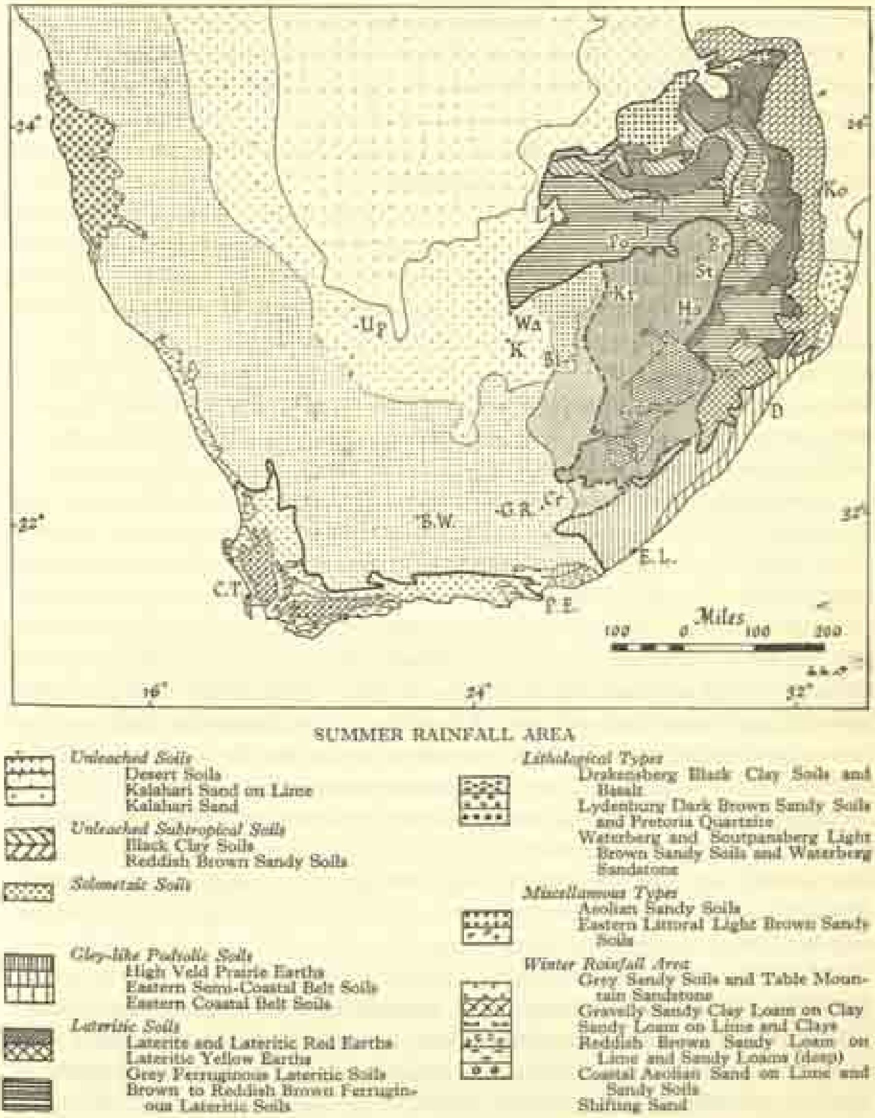


Fig. 39. Soil groups and sub-groups of South Africa.

(After C. R. van der Merwe.) The thick black lines separate the main soil groups.

and Lateritic soil zones and again immediately east of the Drakensberg the soils are of intermediate character. They consist of a dark surface layer, below which is a slightly bleached horizon, underlain by a compact layer in which the sesquioxides and clay particles have accumulated. In profile they, therefore, resemble podsols. But they are devoid of acid humus and have only a moderately acid reaction; moreover, their profile is characterized by the presence of free alumina and a layer of iron concretions resulting from the mobility of the iron compounds under waterlogged conditions in the C horizon; preferential leaching of silica, alumina and soda in the form of silicates has also taken place; these are all features of laterization processes. Two types of soil have developed according to the physical conditions – the Brown to Reddish-Brown Ferruginous Lateritic Soils and the Grey Ferruginous Lateritic Soils.

The Brown to Reddish-Brown Lateritic Soils have developed over a wide stretch of country of very varied environmental conditions – from the level surface of the Highveld to the ridges and valleys of the Bankeveld and the hilly country of the Natal Middleveld, under an annual rainfall varying from 17 to 35 inches, over rocks ranging from superficial sands, shales, quartzites and dolomite to diabase and granite and under a vegetative cover varying from grassland to savanna. Yet everywhere the soils are similar, consisting of a friable sand or sandy loam, containing iron concretions or even a ferruginous hardpan in its lower portion, underlain by an impervious clay which impedes the drainage and enables the iron compounds to become mobile and form concretions. Soils of this type develop only where waterlogged conditions develop periodically in the C horizon, either as a result of the rapid percolation of rain-water as is the case where the highly porous Kalahari sands mantle the surface in the drier west or because of the inability of non-porous rock to cope with torrential showers as in the east. The soils, however, vary according to the relief and the nature of the parent material. Thus very little soil has formed over the quartzite ridges of the Bankeveld and only thin soils cover shale outcrops. By contrast on gently sloping land, particularly where underlain by diabase, granite or sandstone, the soils may be quite deep. Catenary changes are evident, from thin stony soils over the ridges to well developed soils on the intermediate gentle slopes to dark brown clays, susceptible to gully erosion, in the valleys. Everywhere the soils are leached of their mineral constituents and contain little organic matter. Their agricultural potential depends very largely on the depth of the ferruginous layer and whether or not it is cemented into a hardpan impeding drainage.

The Grey Ferruginous Lateritic Soils have formed over the Red Granite of the Bushveld and the Old Granite of the Pietersburg plateau and Lowveld, where great diurnal variations of temperature have favoured the break-up of the granite into large boulders associated with fine sandy material. The surface drainage is good but partially decomposed rock impedes the internal drainage so that temporary waterlogged conditions occur after torrential summer thundershowers and the iron compounds become mobile. The weathering processes proceed in fits

and starts and result in the formation of soils comprising an A horizon of some 12 to 24 inches of friable sand becoming gravelly and studded with a few ferruginous concretions with depth, overlying a B horizon of mottled clayey-sand containing many ferruginous concretions which in the lower part are cemented to form a hardpan called 'ouklip'. Where the drainage is better, as on steep slopes, the hardpan is absent and the soils consist of reddish sands showing little change in character to a depth of 5 feet. The ferruginous layer is again absent in low lying poorly drained areas near spruits where the soils comprise grey sands overlying deflocculated gravelly sandy-clay which is compact and impervious and on drying shrinks into columns.

Agriculturally the ferruginous lateritic soils are poor, despite a vegetative cover of trees and tall grasses which respectively shed their leaves and die down in the winter. They are generally sandy and deficient in plant nutrients; while they absorb water readily, their moisture-retaining capacity is very low; and they become waterlogged after rain. Generally speaking it is only where intrazonal types develop, as along spruits, that crops can be raised successfully.

Unleached Sub-tropical Soils

Where the annual rainfall is less than 20 inches and occurs in summer thundershowers of short duration unleached sub-tropical soils are found. There are two main types – Sub-tropical Black Clays and Sub-tropical Brown Forest soils.

The Sub-tropical Black Clays occur where norite or Stormberg basalt underlie the surface in the Transvaal Bushveld. They comprise heavy black clays which become extremely sticky when wet but on drying contract into columns which break up into clods near the surface; near the surface they contain abundant grass roots and a few carbonate of lime nodules; these nodules increase with depth and occasionally form a thin layer of soft nodular calcium carbonate. Otherwise there is little profile differentiation and the black clay directly overlies the decomposing norite. The content of lime, magnesia, soda and potash is high throughout the profile; the pH varies from neutral to slightly alkaline with a tendency to increase with depth. The humus content is low – much too low to account for the black colour of the soils.

These soils have developed under the same climatic conditions as the ferruginous lateritic soils; the vegetation differs in the predominance of grasses and paucity of trees but the outstanding features of the soils – their black colour, high mineral content and heavy texture – are considered to be due to the nature of the norite. Composed largely of plagioclase and pyroxenes, the latter containing iron in a ferrous state, the norite weathers to a heavy clay which has a volume expansion of 50 per cent, so that when it becomes wet air is effectively excluded and drainage impeded. In consequence the iron compounds remain in a ferrous state, thereby imparting a black colour to the soil, and leaching is arrested so that the alkaline earth carbonates are retained. Similar soils, probably formed in a similar way, overlie the basalt. Where, however, the norite

is in contact with magnetite bands or with the Bushveld granite and again where the basalt is in proximity to sandstone or overlain by superficial sands, the soils, derived from an admixture of material, have a characteristically reddish colour, are light textured and have been leached of their alkaline earths. These differences are probably due to the greater porosity and improved aeration imparted by the quartz grains from the granite and sands and the iron oxide from the magnetite which in turn have facilitated the oxidation of the iron compounds (thereby imparting the red colour) and encouraged the leaching of the mineral salts.

The Black Clays provide good soils for dry land cultivation. When dry the surface layer has a crumbly to granular structure but after rain the whole soil becomes sticky to a considerable depth and quite intractable for machinery and vehicles which become 'bogged down'. Under dryland cultivation the soils are self-mulching, cracking on drying and breaking up into small crumbs, but when crops are grown under irrigation in winter the soil remains moist throughout the year and has no opportunity of drying out, with consequent deterioration in structure. The soils, particularly those derived from the basalt, are naturally well supplied with mineral nutrients and despite a high magnesia content, usually associated with infertility, yield good crops in years of good rainfall without the application of artificial fertilizers. The red soils are inherently less fertile but their structure is better, making them more suited to tree crops and those field crops such as peanuts which succeed in lighter soils.

In the Lowveld country east of the Drakensberg the soils are of the Sub-tropical Brown Forest type. Unlike the Sub-tropical Black Clays they owe their characteristic features to soil forming processes governed by the prevailing climatic conditions – notably the high temperatures throughout the year, and the erratic incidence of the rainfall, which comes in torrential downpours in summer separated by long dry periods. The high temperatures and rain bring about the solution of all the mineral constituents, except the iron compounds and the alumino-silicates (as in laterization) but the dry spells are unfavourable for their removal. Consequently the soils have suffered little leaching of their bases, and their reaction is only slightly acid at the surface, and becomes neutral to alkaline with depth. They are generally shallow and of a skeletal nature for although the decomposition of the parent material is intense, surface erosion during and after the torrential downpours keeps pace with it. Their humus content is low, for frequent veld fires destroy the organic matter which, further, undergoes rapid mineralization under the high temperature conditions. Beyond these similarities the soils vary with the nature of their parent material. Thus greyish-brown sandy loams occur over the granite, brown clay-loams have developed from the basalt of the Lebombo Flats and dark chocolate clays over Ecca shales and dolerite. In the Tugela basin of Natal, where the climatic conditions resemble those of the Low-veld, similar soils, mainly chocolate stony loams, prevail. As yet little is known of the agricultural potentialities of these soils for they occur in areas which are only on the fringe of development but they are probably inherently more fertile than

most tropical soils. Those developed from the basalt in particular promise good returns under correct management.

Soils of the Winter Rainfall Zone

In the south-western and southern Cape the climatic conditions are peculiarly unfavourable to soil formation for the rainfall occurs in winter when the temperatures are low for chemical activity but not low enough for frost action to become important. In summer drought precludes chemical action and weathering is largely dependent on the shattering of the rocks as a result of diurnal changes of temperature. The vegetation – sclerophyllous evergreen bush – contributes little in the way of organic matter. Most of the soils are thin; they show evidence of podsolization but their structure and composition depend very much on local conditions of relief, climate and parent material.

On the Cape mountains there is little opportunity for soil formation for the resistant quartzites weather very slowly and the high rainfall and steep slopes lead to rapid removal of the weathered product. Where the slopes are gentler a little soil has accumulated in pockets between rock outcrops;[7] it consists of a dark brown sand with a fair amount of organic matter passing down to a lighter sandy loam and sandy clay, which overlies the parent rock; it varies in depth from a few inches to about 4 feet but is everywhere sandy, acid and deficient in plant nutrients and humus; agriculturally it is worthless.

In the lower-lying plains, intermontane basins and valleys, where shales of Malmesbury and Bokkeveld age outcrop and where the rainfall is considerably lower and of more gentle nature, shallow soils again predominate, but they are of more loamy texture, less acid in reaction, and better supplied with mineral constituents. Varying in depth from a few inches to about 30 inches, they usually consist of crumbly gravelly loams containing occasional ferruginous concretions, overlying compact and impervious gravelly or sandy clays. They possess an excellent texture and good water absorbing and retaining capacities and since they occur in areas where the relief and climate are favourable for agriculture, many of them have been under cultivation for a long period. In consequence their original character has been much altered. In many instances the material of the A and B horizons has become mixed, while in places erosion has completely removed the A horizon. The mineral composition of the soils has been much modified by crop production and the application of fertilizers so that today they are well supplied with phosphoric oxide, potash, magnesia and soda, all of which increase with depth. Due to the leaching of organic matter, however, the contents of nitrogen and carbon are low near the surface but increase with depth.[8]

In the western lowland numerous small mounds or 'heuweltjies' of uncertain origin diversify the otherwise level surface. The surface soil over these mounds is similar to that of the surrounding ground but the B horizon differs, being a soft calcareous loam. In consequence these soils are of greater inherent fertility.

The Soils of the All-season Rainfall Zone

In the south-eastern Cape the rainfall varies with relief and distance from the sea from about 12 to 27 inches and since it occurs in gentle showers evenly distributed throughout the year, intense leaching is not a factor in soil formation. Instead the character of the soil is most influenced by the nature of the underlying geological formation and by the vegetative cover and varies considerably within short distances. Where the Tertiary limestone comes to the surface between the Sundays river, Uitenhage and Port Elizabeth, only a few inches of reddish-brown sand has formed between rock outcrops whereas deep crumbly to granular clay loams or clays overlying denser clays have weathered from the clays and shales of the Uitenhage series (Cretaceous); in places these support only succulents and Karoo shrubs which contribute little organic matter, but elsewhere, where the indigenous bush is dense, the surface layer is so well supplied with organic matter that it is sometimes removed from virgin land and carted to the arable fields. Reddish-brown sandy loams have developed over the Tertiary calcareous sandstones (Alexandra beds) in the coastal lowland east of the Sundays river, but the subsoil varies according to the thickness of the beds, being a sandy loam mixed with limestone fragments where they are thick, and a clay loam where they form only a thin layer over the Bokkeveld shale. The major valleys traversing these soil zones are paralleled by alluvial terraces on which the soil varies from a coarse sand to a fine sandy loam; the parent material has been derived from the Karoo beds of the arid area to the north and contains high proportions of alkali salts which under the prevailing climatic conditions are not leached out. Generally speaking the alluvial soils have a good structure and are inherently fertile but they require careful management if brak troubles are to be avoided when the land is irrigated.

Miscellaneous Soils

In places the parent material is more important than climatic and vegetational influences in determining the character of the soil and produces lithological types within the major groups. Thus within the Gley-like Podsolic soil zone the basaltic lava of the Basutoland mountains has given rise to black clays, resembling those derived from the dolerite on the Highveld. Thin sandy soils, well supplied with raw humus, have formed over the ridges of the Steenkampsberg and Drakensberg near Lydenburg where they contrast with the surrounding lateritic soils. Again poor sandy soils, deficient in plant nutrients and incapable of holding moisture have developed from the Waterberg sandstone of the Waterberg plateau and Soutpansberg; they contrast both with the neighbouring laterite and Kalahari sand on lime.

Along the coasts of the western and south-western Cape and again in Zululand, the character of the soil is determined by a thick mantle of sand, in places more than 70 feet thick. Sand dunes parallel the coast and behind them the coastal plain has a sand cover of variable thickness. In the Cape the surface 'soil'

is a sand, but where the cover is thin, it may pass downwards to a limestone as between Mossel Bay and Cape Agulhas and again between Langebaan and the Olifants river, or to a clay as near Hopefield and in Namaqualand; elsewhere it consists of loose sand, sometimes shifting, to considerable depths. In Zululand the troughs between the coastal dunes are in places occupied by fine sands; elsewhere they form marshy tracts where the surface sands are underlain by impervious clays at shallow depths. Inland the plain is covered with deep sand and the soils are excessively porous and, in spite of a dense bush cover, deficient in organic matter; the watercourses are in places paralleled by brackish black clays which are dry in winter but become sticky after summer rains, and elsewhere by coarse sandy alluvium.

Scattered throughout the country are patches of saline soil, developed particularly in the troughs between the coastal dunes and where there are shallow depressions or pans along the surface drainage lines in the interior.

From the agricultural standpoint the soils of Southern Africa are generally poor and difficult to manage.[9, 10] In the first place most of them are residual and have been derived very largely by mechanical weathering from ancient rocks of continental origin. Consequently the particles which eventually make up the soil are angular and under cultivation tend to compact; the soil structure is lost and erosion follows. Experiments at Cedara College of Agriculture have revealed that whereas under natural veld a soil consists of about 30 per cent of crumbs exceeding 2 mm. in diameter, the proportion falls to 17 per cent after ploughing and to less than 4 per cent both after continuous cropping for twenty years and directly after the introduction of a system of winter crops under irrigation and summer fallow. Such conditions are practically unknown in the agricultural areas of Europe and North America where the soils are derived mainly from transported material weathered from rocks originally laid down under water and worked upon by chemical action so that they have well rounded particles which maintain a good structure. Secondly, the climatic conditions are such that soil formation is very slow over the western half of the country, while in the east it proceeds in fits and starts and is characterized by severe leaching during the active periods. Moreover, thirdly, the high altitudes over the greater part of the country and steep peripheral slopes result in the removal of soil material almost as soon as it is formed. Consequently, most soils are thin, often skeletal, and deficient in mineral constituents, particularly phosphoric oxide. Fourthly, over much of the country the drought-resistant vegetation contributes little organic matter to the soils, while elsewhere the destruction wrought by ants, termites and other small animals and the practice of veld burning rob the soil of this valuable constituent. Fifthly, in the wetter parts of the country the soils show an acute phosphate deficiency.[11, 12] This is due mainly to excessive leaching with which is coupled the tendency for the phosphoric-oxide in the soil to combine with other mineral constituents,

notably iron and aluminium compounds, and become fixed and unavailable to plants. The deficiency, however, may be due partly to the destruction through repeated veld burning of the bacteria and other micro-organisms which normally break down the various minerals in the soil thereby making them available to plants. Lastly, in some instances, the same processes which produce the soils render their improvement by fertilizer treatment very difficult. This is particularly so in the case of the lateritic soils, from which not only are fertilizers leached away but certain mineral constituents, especially phosphoric oxide, react with the aluminium compounds and become fixed and unavailable to plants. Nevertheless much can be done with good management, crop rotation and wise fertilization, provided the nature of the soil and the way in which it has been formed are fully understood, for soil formation never comes to a halt, it goes on all the time.

BIBLIOGRAPHY

1. C. R. van der MERWE. *Soil Groups and Sub-Groups of South Africa*, Union of S.A. Dept. Agric. Sc. Bull., No. 231, Pretoria. 1941. Most of the information given in this chapter is derived from this source.
2. See M. S. du TOIT and J. REYNECKE. 'Profile studies in the Western Province with reference to hardpan formation'. *S.A.J.Sc.*, Vol. XXVII, 1930.
3. See B. de C. MARCHARD. 'Representative Transvaal soils: (iv) the Highveld Sandy Soil', *S.A. Dept. Agric. J.*, 1923, pp. 82–5.
4. See B. G. SMIT. 'Representative Transvaal soils: (vii) the Highveld Black Turf', *S.A. Dept. Agric. J.*, 1924, pp. 527–31.
5. See J. J. THERON and P. le R. van NIEKERK. 'The nature and origin of Black Turf soils', *S.A.J.Sc.*, Vol. XXXI, 1934.
6. See B. de C. MARCHARD. 'The origin of Black Turf soils in the Transvaal', *S.A.J.Sc.*, Vol. XXI, 1924, pp. 161–81.
7. See C. F. JURITZ. *Study of the Agricultural Soils of the Cape Colony*. 1910.
8. See W. E. ISAAC. 'The organic matter content and the carbon/nitrogen ratio of South African soils of the winter rainfall area', *T.R.S.S.A.*, Vol. XXIII, 1935–6.
9. See G. HYAM. 'Crumb structure of the soil', *F. in S.A.*, Vol. XXV, 1950.
10. See I. de V. MALHERBE. 'Some outstanding factors relating to the fertility of South African soils', *S.A.J.Sc.*, Vol. XXVI, 1929.
11. See J. P. van ZYL. 'Phosphorus deficiency in South African soils and vegetation', *S.A.J.Sc.*, Vol. XXIII, 1926, pp. 244–52.
12. See P. C. J. OBERHOLZER. *The present state of citrus nutrition in South Africa*, Union of S.A., Dept. Agric. Sc. Bull., No. 271, 1946–7.

The Occupation of Southern Africa

5

The Native Peoples, the Early History and Discovery of Southern Africa

The Native Peoples

There is little doubt that human settlement and culture in Southern Africa go back to very early times. The fossil skulls discovered at Sterkfontein and Taungs suggest that Africa may even have been the scene of man's evolution. Little is known of the early apeman but the palaeolithic implements which are commonly found in South Africa today testify to its former occupance by peoples of whom no other trace remains.

When the first European settlers set foot in South Africa just over four hundred years ago there were peoples of two distinct groups occupying different parts of the country – the Bushmen, who were the barbaric nomadic hunters of the desert upland country to the west, and the semi-civilized pastoral Hottentots who occupied the coastal belt to the south and east.[1] A third group comprising the Bantu tribes was entering from the north and overrunning much of the land in the east and north.

Although little is known of the origin of these peoples, there is little doubt that internal migrations of population had been going on in the African continent from very early times, and, coupled with the invasions of people of Asiatic origin along the east coast, had led to much intermingling of blood, culture and language, so that each group owed something of its characteristic features to another.[2] It seems certain, however, that the Bushmen represented the most primitive group, perhaps being related to prehistoric types of man. The Hottentots were somewhat more advanced, perhaps related to the Brown or Mediterranean race which peopled both Africa and southern Europe in Neolithic times. The Bantu were of more recent negroid stock having originated probably in east central Africa from intermarriage between Negroes and Hamites; at a later date, the eastern Bantu received some admixture of Arab blood.

The Bushmen were little people with negroid facial features but lacked the projecting mouth and thick everted lips of both negro and negrito. They were

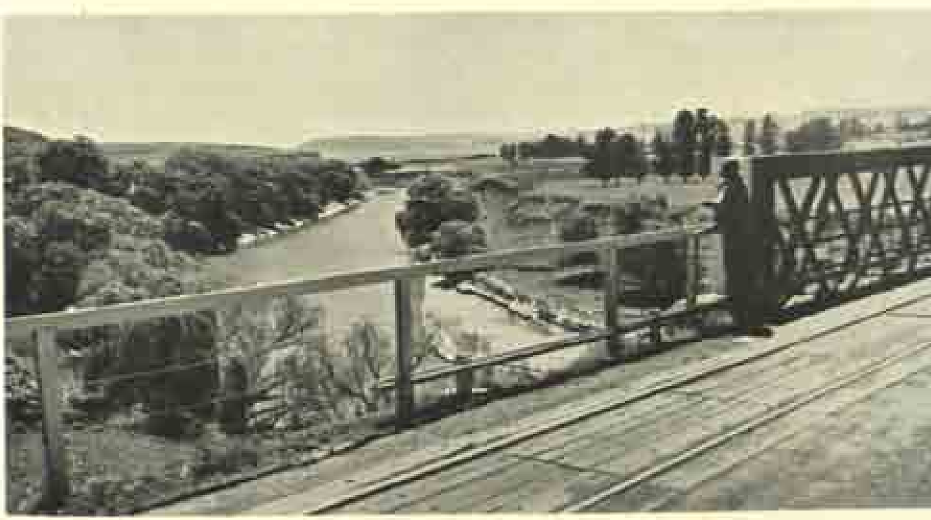
distinguished by their yellowish-brown skin and the excessive development of fatty tissue on the buttocks. Essentially hunters dependent on the wild game which formerly abounded in the southern part of the continent, their social organization was dictated by the necessity to follow the movements of the animals.[3] They were loosely knit in little hunting bands, each 'owning' a definite hunting territory. In summer, after the rains, when the streams carried water, pasture was 'plentiful' and the animals scattered over the veld, the Bushmen likewise spread out in pursuit of them. Later when the sun had scorched the grass and dried up the supplies of water until only a few pools around which the animals concentrated were left, the Bushmen set up camp a few miles away. Their dwellings were extremely primitive, consisting of half-domes of light sticks interwoven with twigs and thatched with grass. While the big game afforded their main supply of food, the women gathered roots and berries and small animals. Water was collected in ostrich egg-shells and dried bucks' stomachs. These people had few crafts. They used wood for making bows and bone for arrows. They were skilled flint workers while the paintings found on the walls and roofs of caves throughout eastern and southern Africa are attributed to their ancestors (see Plate 29).

The Hottentots probably originated as a result of intermarriage between Bushmen[4, 5] and an early Hamitic stock possibly on the East African plateau. Thence they moved south-westwards by way of the upper basin of the Zambesi into South Africa. By culture they were pastoral nomads possessing cattle and sheep. Their dwellings were of a rather more permanent nature than those of the Bushmen and their encampments consisted of a group of beehive huts and a cattle fold enclosed by a thorn fence. They had some knowledge of basket and mat weaving and could smelt iron. These were the people with whom the Europeans first came in contact and who felt the full impact of the new order on their settlement and their economy.

The Bantu tribes[6, 7, 8] possessed a more complex culture which in varying degrees owed something to both Hamitic and Negroid influences. Thus they combined the pastoral activities of the Hamites with the hoe cultivation of the Negroes, the former tending to nomadism and the attack of weaker neighbours, the latter to settled occupation of the land and peace. Both tendencies were present in most tribes although some like the Zulus took to war more readily than others. Their huts usually consisted of round mud walls and conical thatched roofs recalling the Negro dwellings, but true beehive huts consisting of a framework of supple poles covered with grass or skins, reminiscent of the Hamitic culture, were and still are favoured, significantly, by the Zulus, the most warlike tribe. Except in Bechuanaland the settlements were usually dispersed, comprising a family unit composed of a group of huts and a cattle fold surrounded by a fence of thorns or aloes.

Apart from the Hereros[9] of South-west Africa who were purely pastoralists, the Bantu were cattle herders who occupied a given stretch of country for two or

29. Bushman paintings on the wall of a cave in the Cave Sandstone near Nottingham Road, Natal.



30. The long-disputed Caledon river lands from the bridge at Maseru.

31. Vaaldam. View from below the dam wall showing, in the foreground, the Vaal river cutting through the Ventersdorp lavas and, in the background, the level Highveld developed over Karoo rocks.

32. Loskop dam. View south-westwards to the plateau formed by the Waterberg sandstone, with the southerly dip of the rocks clearly visible.

33. Privately owned irrigation dam typical of the fruit-growing areas of the south-western Cape, in this case in the Elgin Basin.

three years, grew two or three crops of kaffir corn and then moved on to new land. The men were the herdsmen and warriors, the women the tillers of the soil and drawers of water. So important a place did the cattle occupy in their economy that the 'lobola' or bride price, which survives to this day, was given in cattle. It should be appreciated, however, that cattle were considered not so much as a medium of exchange as in part a symbol of wealth and in part one of the society to which the people belonged linked up with its good or evil fortune, and that it is only contact with European ideas that has led to the rigid fixing of the 'lobola' and the substitution of a money payment. The importance of an economy necessitating movement every few years and frequently the dispossession of sedentary tribes in order to obtain arable land, and of the measurement of wealth in numbers of cattle must be appreciated for a proper understanding of the course of history and of the many problems which beset native agriculture today. Further the Bantu concept of land ownership was completely different from that of the European. They looked on land as belonging to everyone in the past, present and future, but of value only when used for grazing or cultivation. Hence the granting of land entailed merely permission to use it for a limited period of time. Such was the understanding on which many of the grants of land to Europeans were made.

When the first Europeans arrived in South Africa great movements of population within the sub-continent were in full swing. Before the advancing Bantu the Hottentots had retreated to the southern Cape and the Bushmen to the Kalahari. The Bantu were sweeping southwards across Southern Rhodesia where they divided into two main streams, one moving across the low plateau of eastern Bechuanaland and the other and more powerful one entering the foothill belt below the Drakensberg escarpment. The treeless Highveld plateau of South Africa with its severe climate and scarcity of surface water was avoided by the more powerful tribes who preferred the sub-tropical eastern marginal belt where water, grazing and wood were plentiful and the temperatures high enough to obviate the need for special protection for man and beast. The southward movement of these people was only halted by the arrival of the vanguard of European settlers in the south-eastern Cape, where the clash of the two races in the district still known as 'Border' not only led to conflicts but dictated the progress and direction of subsequent European movement and settlement.

During their southward movements the many tribes comprising the Bantu group formed and re-formed largely as a result of intertribal wars and, later, wars with the Europeans. Most important was the havoc wrought by Chaka, the Zulu king, who overran much of south-eastern Africa between 1818 and 1828 in the period immediately preceding the clash of European and Bantu in the south-eastern Cape. He drove the neighbouring Angoni and Shongaans northwards to carry destruction through the eastern coastlands behind the Portuguese settlement in Mozambique, and then stabbed his way through Natal. He even crossed the Drakensberg but the havoc wrought there was due to one of his impis, who fell foul of his master and fled with his followers to the southern and western

Transvaal. The remnants of the Bechuana found refuge from him in the Kalahari, while in the mountain fastnesses of Basutoland Moshesh gathered under his wing the remnants of many broken tribes. In the north the Matabele[10] were similarly destroying their weaker neighbours, while later in the century, in the mountains and valleys of Sekukuniland, Sekukuni drew together the broken Bapedi and other tribes seeking refuge. The Europeans first made contact with

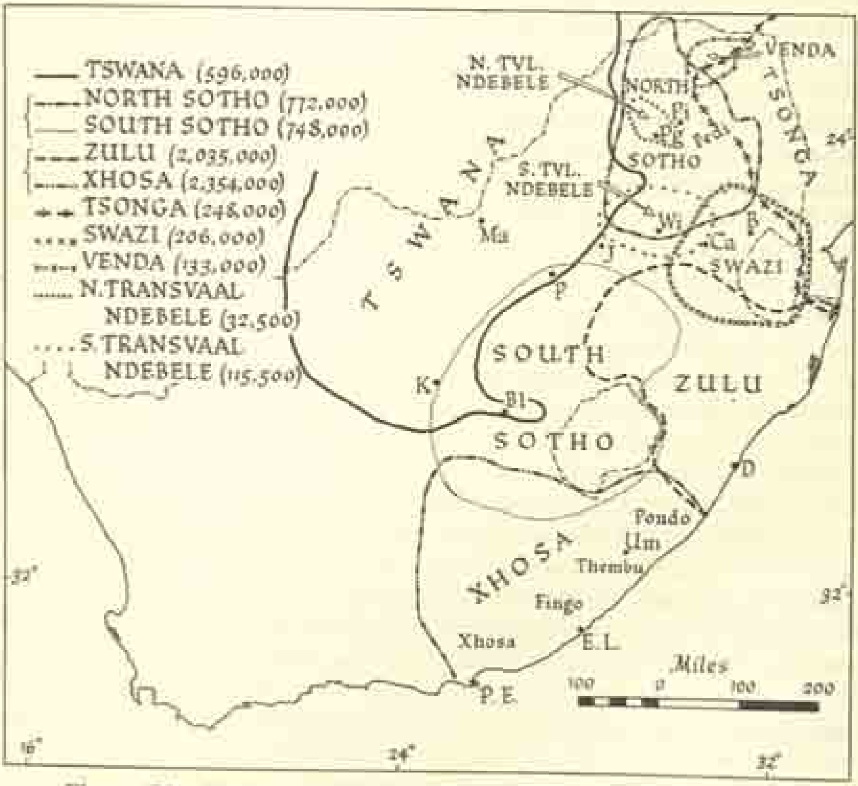


Fig. 40. Distribution of the main Bantu language groups and tribes.
(Language groups after N. J. van Warmelo; number of speakers, based on 1946 census, given in brackets.)

the Bantu when Chaka was causing tribes to flee in all directions. Conflict with the Europeans caused further regrouping of some of the tribes with whom they came in contact.

During all these events differences of speech and custom developed between the various tribes and in some cases internecine war bred intertribal hatred.[11] Today four main groups, distinguished on the grounds of language,[12] are generally recognized (see Fig. 40). Thus the tribes occupying the south-east coast from Zululand to the Ciskei belong to a group speaking the languages which are

most influenced by Bushman–Hottentot clicks. The peoples of Bechuanaland, the Transvaal, Orange Free State and Basutoland belong to the Tshwana–Sotho language group, those of the eastern Transvaal and Mozambique speak Tsonga and those of South-west Africa Herero. Within each language group there are many dialects which hinder education and discourage the tribes from uniting with one another. Some tribes are more numerous and more important than others. Between some, e.g. Zulu and Basuto, old feuds linger on only to erupt from time to time where the two live side by side in urban areas.

Early History and Discovery

Little is known of the early history of the southern part of Africa. There are several stories from the Ancient World relating to the circumnavigation of the continent but there is no proof that such voyages, if made, were successful. The Arabs, on the other hand, are known to have extended their influence along the east coast from the tenth century A.D. onwards and their contacts with the Bantu are the first of which we have any record.

The Arabs were essentially traders with whom the Bantu bartered their gold and ivory, leopard skins and tortoiseshell. At times they mixed freely with the Bantu, at others the Bantu rose against them. We do not know how far south or how far inland Arab influence extended but the great Zimbabwe ruins near Umtali in Southern Rhodesia are now considered to be the work of the indigenous Bantu carried out under the stimulus of Arabs who traded with India, whither most of the gold which was mined in the area was exported. It is improbable that the Arabs reached what is now the Union of South Africa but they no doubt exerted a considerable influence on the Bantu peoples of East Africa who were later to sweep southwards into this territory.

The discovery or rediscovery of the Cape of Good Hope by Bartholomew Diaz in 1487 opened a new chapter for it foreshadowed the decline of Arab influence both in the Indian trade and along the African coast and prepared the way for the later European occupation of Southern Africa. The Cape in fact not only occupied a commanding position on the route to India and the Indies discovered by Vasco de Gama in 1498 but commanded the gateway to the interior of Africa as well, although this was not recognized until two centuries later.

Within twenty years of their discovery of the Cape route the Portuguese had broken the Arab domination of the Indian ocean which had been unchallenged for centuries, and had built their East Indian Empire. By so doing they had in fact ensured the later domination of European and not Arab influence in Southern Africa. The Portuguese, however, were primarily interested in trade. South Africa with its temperate climate and vegetation could provide none of the tropical commodities which made the eastern trade so profitable. Its native inhabitants – the Hottentots – were uncivilized and hostile. They did not produce articles comparable with the silk and metal work of Asia, while they slew most of the party which attempted a landing in Table Bay in 1510. Elsewhere the coasts were

dangerous and sheltered harbours few; on the west coast Saldanha Bay and Walvis Bay were backed by waterless country, on the east Delagoa Bay was fever-ridden. So the Portuguese preferred to use St Helena as a port of call and to establish their stations on the east coast where there had long been trading connexions. Here Mozambique, Sofala and Mombasa were captured and fortified for the defence of their East Indian Empire. Thus the Cape was by-passed and for a century and a half no European settlement was made in Southern Africa.

The Dutch, who had successfully challenged the Portuguese maritime supremacy, were the first to appreciate the importance of the Cape on the route to the Indies, and to effect a European settlement in South Africa. This was made in 1652 when a party under the command of Jan van Riebeeck was sent out by the Dutch East India Company with instructions to build a fort on the shores of Table Bay and to furnish provisions, particularly fresh fruit and vegetables for the crews of passing ships. Henceforth the Cape replaced St Helena as a victualling station; and around the little Dutch foothold Cape Town was destined to grow and become the jumping off ground for the colonization of half a continent.

BIBLIOGRAPHY

1. G. M. THEAL. *History and Ethnography of Africa, South of the Zambesi, Before 1795*, 3 vols. London. 1910.
2. R. A. DART, A. W. HOERNLE, and C. M. DOKE. 'The Natives of South Africa. An Ethnographic Review', in the *Yearbook of the Union of South Africa*, No. 7, 1910–24.
3. C. DARYLL FORDE. *Habitat, Economy and Society*. London, 1934.
4. I. SHAPERA. 'A preliminary consideration of the relationship between Hottentots and Bushmen', *S.A.J.Sc.*, Vol. XXIII, 1926, pp. 883–66.
5. I. SHAPERA. *The Khoisan Peoples of South Africa*. London. 1930.
6. N. J. WARMELO. *A Preliminary Survey of the Bantu Tribes of South Africa*, Dept. of Native Affairs, Ethnological Publication No. 5, Pretoria. 1935.
7. A. M. D. CRONIN. *The Bantu Tribes of South Africa*. Kimberley. 1934.
8. I. SHAPERA. *The Bantu-speaking Tribes of South Africa*. London. 1937.
9. *The Native Tribes of South West Africa*. Cape Town. 1928.
10. See G. W. STOW. *The Native Races of Africa*. London. 1905.
11. See J. H. SOGA. *The South-Eastern Bantu*. Johannesburg. 1930.
12. See C. G. SELIGMAN. *Races of Africa*. London. 1930.

6

The Progress of Settlement

The Settlement of the south-western Cape 1652–1700

The shore of Table Bay was chosen for the establishment of the victualling station of the Good Hope largely for geographical reasons. Here, about halfway between Europe and the East Indies, the old outward and homeward sailing routes, dictated by the wind systems of the Atlantic and Indian oceans, approached one another.[1, 2, 3] Neither Table Bay nor False Bay offered a really good or safe anchorage, each being exposed to strong prevailing winds for part of the year, but along a coast lacking in good harbours they did offer partial shelter. Moreover, Table Mountain stood out as a landmark for the early navigators.[4]

The Dutch foothold was to be simply a refreshment station for provisioning the passing ships of the Dutch East India Company. The Company had no thought of settlement and its officers looked forward only to the day when they would be promoted to more lucrative posts in the Indies.[5] They had, however, to secure a meat supply and produce fruit and vegetables. The former could be achieved only by bartering cattle and sheep from the Hottentots, a task which was successfully accomplished, since the Europeans found the Hottentots on the whole hospitable, although dirty and indolent. The Company's attempts at agriculture on the slopes below Table Mountain, however, were not successful. Except for wheat, which was flattened by the south-easters sweeping down over Table Mountain, the crops grew well but, as servants of the Company, the people had little interest in farming and their labour was inefficient and costly.

At first the Company did not permit colonization but because of the failure to produce sufficient meat, grain and wine it decided in 1657 to change its policy and to allow some of its servants to become 'free burghers' and landholders in the more sheltered Liesbeeck valley.[6] This marks the beginning of European settlement in South Africa. However, with the tradition of the Indies behind them and faced with a shortage of labour on their farms the free burghers soon demanded slaves. Van Riebeeck gave way and the first year of the Liesbeeck settlement witnessed the import of slaves from Java, Madagascar and West Africa. Soon

detribalized Hottentots, and Moslems from India were added to the population of the Colony. The scarcity of European women had already led to mixed marriages. Now miscegenation[7] of all elements began and before long the Cape Coloured folk began to emerge.

In the early years of the Good Hope settlement parties were sent out to barter cattle from the Hottentots and to ascertain the economic resources of the hinterland. Their routes[8] were necessarily dictated by the physique of the country. One, northwestwards, lay at the western foot of the first mountain range and followed the line of the Great Berg river. Here the country as far north as the present Van Rhynsdorp became known by 1661. Another route, to the south-east, after crossing the Hottentot Holland mountains near the present Sir Lowry Pass lay to the south of the Sonder Einde Bergen and followed the Eerste river, whence Mossel Bay was reached in 1667. Settlement, however, did not spread beyond the Liesbeeck valley until 1679 for to the east lay the barren flats of shifting sand connecting the Cape Peninsula to the mainland, and beyond them the Hottentots roamed much of the country. In 1679, however, desirous of increasing the flow of food to the halfway house and of strengthening the Dutch hold against French, English and Danes, the Company opened stations at Saldanha Bay and Fishhoek, led their cattle to graze on the Tygerberg, and the Hottentot Hollands, and gave land to free burghers around the newly founded village of Stellenbosch in the fertile Eerste river valley. From there settlement gradually spread down the Great Berg valley where French Huguenots, who had fled to the Netherlands following the revocation of the Edict of Nantes in 1685, were interspersed among Dutch and German settlers. In this way Drakenstein and French Hoek were founded in 1687 and Paarl in 1688.

This spread of settlement into the valleys of the south-western Cape marks the second stage of the colonization of the sub-continent. To the west the sandy Cape Flats effectively isolated the new settlements from the Company's centre on Table Bay. To the east the high wall of the Cape mountains hemmed them in. The presence of these barriers encouraged the growth of real communities in each of the valleys. Here the climate favoured the production of winter wheat and, where irrigation was possible in the dry summers, of deciduous fruits. Distance from the Cape Town market encouraged wine manufacture and fruit drying and these industries gave some permanence to the settlement and strengthened the attachment to farm and home. But the early years of the new settlements were years of trial, disaster, and discouragement. The local market was small, the Cape itself was remote from other parts of the world, the wheat more expensive than that of Holland or Surat, the wine inferior to that of Europe. Neither the Netherlands nor Batavia would accept this produce, while in the Cape itself the Company maintained a stranglehold over the sale of all agricultural commodities. Discontent was rife and many resented the control of the company.

By the end of the century most of the valley lands suitable for settled agriculture had been occupied. Northwards with decreasing rainfall crop production

became more and more precarious; the country was more suitable for pastoral pursuits. A generation had grown up since 1679 and it hungered for land. The time had come for expansion beyond the confines of the valleys and with the discovery of routes to the north-west, where copper had been found at O'Okiep in 1685, and to the Roodezand Pass leading to the Tulbagh basin and thence the Breede river valley in 1699, many trekked off to new lands. The pastoral phase had begun but the trekkers left behind them settled agricultural communities in the valleys of the south-western Cape.

The Extension of Pastoral Activities and the Occupation of the Karoo and Cape Folded Belt 1700–70

From the first the demand for meat, the poor rewards for crop production and difficulties of transport had encouraged the Boers to become cattle farmers, and despite the laws against such activities some had trekked off beyond the frontier of the colony, bartered sheep and cattle from the Hottentots and accumulated big flocks and herds. Rugged and independent in outlook, these people led the trek over the mountain passes and into the valleys beyond.[9]

Relief features dictated the routes followed. Moving northwards there were three main streams. One moved along the coastal plain to the Olifants river. Another went by way of Tulbagh and then followed the Olifants river to the Clanwilliam district and the third crossed the second series of ranges into the Cold Bokkeveld and the Doorn river valley.[10] Thence northward expansion continued between the western ranges and the Great Escarpment until a break in the latter near Calvinia gave access to the plateau. Here the Zak river was reached in 1760. Meanwhile between 1700 and 1730 the pastoralists moving eastwards crossed the Hottentot Hollands by the Sir Lowry and French Hock passes and occupied the coastal belt south of the Sonde Einde Berge and Langeberge. Others reached the same area via Tulbagh Kloof and the Breede river valley. Between 1730 and 1760 the pastoralists found the Hex river pass by which they reached the Great Karoo. Here the scanty rainfall, level surface and low carrying capacity of the vegetation so stimulated movement that by 1770 the whole area eastwards to Graaff Reinet had been occupied.

Due to the complexity of relief progress was slower in the southern mountain belt. Eastwards the rugged steep-sided gorge of the Gouritz river presented a barrier, northwards the succession of range upon range of mountains. In 1765, however, the Outeniquas were crossed by the Robinson Pass and thence the Long Kloof and Little Karoo were occupied. Settlements then spread along the valleys and on to the coastal plain between Uitenhage and Peddie.

Thus by 1770 the Cape folded region, the Great Karoo and the south-western corner of the plateau had been occupied by the pastoralists.

During the eighteenth century there was little immigration but the Europeans multiplied greatly. The Bushmen and Hottentots, however, declined in number and importance. As the pastoralists spread farther from the Cape the

defence of the frontier passed into their hands and the little hunters were either killed off or driven farther into the Kalahari. The Hottentots suffered a different fate. On the whole their relations with the Europeans were peaceful. Their tribal system gradually decayed and increasing numbers worked on the farms and in the homes of the Europeans. But in 1713 a disastrous outbreak of smallpox in the Cape practically wiped them out. The resulting shortage of labour brought demands for more slaves and unfortunately, despite the pleas of the Captain of the Garrison for increased immigration to this 'White Man's country with its pleasant Mediterranean climate' and for the break-up of the farms into family units, the advocates of slave labour won the day.

By 1770 the European population comprised three distinct groups – the townspeople of the Table Bay settlement, the grain and wine farmers of the Great Berg valley and the pastoralists, each group separated from the other by the physical barriers of the Cape Flats and the Cape mountains. Differences of outlook between the older settlements of the West and the expanding East were marked. The former were agricultural and dependent on slaves, the latter pastoral and centred on the family unit. The slaves worked according to their capacity – e.g. the negroes did the rough work in the fields, the Malays built the beautiful Cape-Dutch gables which distinguish many old farmhouses – and were generally well treated. Their presence, however, discouraged industry on the part of the Europeans and led to the acceptance of inefficiency.

In the east the pastoralists marked out great ranches for themselves.* Frequently in order to ensure both summer and winter grazing they had two in different parts of the country. Their families were large and as the sons grew up they in turn marked out new farms for themselves in unoccupied areas. These people grew up in isolation[11] and cherished their independence. They resented the control from Cape Town, which they visited only to purchase such commodities as brandy, coffee, and cloth and to present themselves and their brides before the hated matrimonial courts. They had lost much of the old western civilization and in many ways their life was rude. But they had occupied the land between the Tulbagh mountains and the Fish and Orange rivers before the Bantu hordes could pour in from the east.

The Settlement of the south-eastern Cape 1770–1836

The longtiudinal valleys of the southern Cape and thence the Sundays river valley led the pastoralists on to the coastal plain of the eastern Province. Here they entered a well-watered region where parallel south-eastward trending valleys offered fertile soils for settled agricultural communities and the heavily bushed interfluves discouraged movement north-eastwards along the coast. Moreover, along the line of the Great Fish river the Europeans encountered the

* The Company granted loans of large tracts of land on a yearly basis to these people. To all intents and purposes these were free grants of land for which a small annual rent was levied after 1714.

advance guard of the southward-sweeping Bantu. The course and nature of settlement in this area was dictated by the relations between the opposing movements of the two peoples.

The last quarter of the eighteenth century witnessed the decay of the Dutch East India Company while war followed war in Europe on into the nineteenth century. The halfway house was inevitably involved and its fortunes waxed and waned with the comings and goings of the foreign ships. Three times it changed hands and was eventually purchased by Britain in 1815. By now settlement had far outstripped the power of the Company or the British to control it and on three sides there was no boundary to the colony. In the east there was general prosperity for the demand for meat was great, but there was trouble in plenty, for European and Bantu had become interlocked along the frontier zone. Between 1779 and 1812 four Kaffir wars had been fought and the frontiers carried to the Koonap river, and in 1815 the Boers had rebelled against the British authorities. Because there could be no peace while the ownership of the land was disputed, in 1820 settlers were brought out from England in order to strengthen the European hold in the area.[12, 13] They were allotted small farms in the Suurveld west of the Sundays river and Port Elizabeth was founded as an outlet for their colony. The geographical conditions permitted fairly close agricultural settlement in this area, but as in the south-western Cape, the early colonists had to contend with the vagaries of the South African climate. Droughts were followed by torrential rains and damaging floods and blight destroyed the first wheat crop. However, the tide turned, Merino sheep were introduced in 1827, both cattle and sheep multiplied and wool soon became a valuable export. Grahamstown and Port Elizabeth developed into thriving little towns.

With the growth of agricultural communities in the south-eastern Cape and the movement towards closer settlement land became less easy to get than formerly. Consequently the pastoralists felt compelled to expand beyond the boundaries of the existing colony. It is true that many of the Boers resented British rule and were inflamed by the abolition of slavery in 1833, and the failure of the British Government to maintain 'proper relations between master and servant', but the root of their discontent was land hunger, and when the free grant of Crown lands was replaced by sale by auction they felt that they had been robbed of their birthright. Expansion beyond the existing frontier of the colony was inevitable. Vacillating British policy merely decided the time at which the movement gathered momentum, while the geographical nature of the country and the distribution of the coloured races determined the path it followed.

The Great Trek and the Occupation of the Highveld 1836–46

The paths followed by the Boer trekkers were determined, in the first instance, by the distribution of the native races. Beyond the Great Fish river most of the land between the Great Escarpment and the sea was occupied by Bantu tribes. The plateau, however, was practically uninhabited. During the period of pastoral

expansion such organized Hottentot tribes as survived had begun to leave the country, the Namaquas moving to what is now South-West Africa, the Korannas to the country about the confluence of the Vaal and Hartz rivers and the Grigriquas together with a bastard group of mixed European and Hottentot descent, later renamed Griquas, to occupy the middle and lower Orange river valley. Otherwise the country was empty. In 1824 the colonial frontier had been carried up to the drifts of the Orange river opposite Philippolis and a year later Boer cattle were grazing among the Griqua herds beyond the river. By 1833 many Boers were living in the areas on land bought or leased from the Griquas. As land hunger in the south-eastern Cape increased and resentment against the British mounted attention was focused on these plateau lands. In 1834 three reconnaissance parties went out to explore the possibilities for expansion, one across the plateau to the Soutpansberg, another through Kaffirland to Natal and a third to South-West Africa. Meanwhile a sixth Kaffir war was fought on the eastern frontier. At its close the frontier was carried to the Great Kei river and farms were offered to Europeans in the Ceded Territory. This might have stopped the great movement, but the British Government reversed the policy and insisted on a return to the old frontier. The loss of land, the loss of faith and the incidence of severe drought precipitated the Great Trek[14, 15, 16] and swelled the numbers joining it.

The trekkers[16] crossed the Orange river by the drifts south of Philippolis and reached the vast grasslands of the Highveld. Here, skirting the eastern mountains and following the watershed between the Vaal tributaries and the Caledon river, they made rapid progress. The grasslands provided good grazing for their flocks and herds, the level surface facilitated rapid movement, the wide horizon gave good warning of enemy attack and the open nature of the country suited the Boer method of fighting; the climate was severe but invigorating; the cold winters checked the growth of parasites and the region was healthy for man and beasts. Winburg was reached in 1837. There the parties divided, possibly because the grazing was no longer able to support the large herds. Piet Retief, anxious to find an outlet to the sea, skirted the Basuto Highlands at their northern end and led his party down from the plateau to the coastal belt where he tried to settle Natal, despite the fact that it was occupied by the mighty Zulu nation. Since 1824 English traders had been dealing in ivory and skins at Port Natal, and in 1835 the settlement had been organized as Durban but Natal had not been annexed, although Dingaan, the Zulu chief had ceded the southern portion of it to the Crown. Retief now obtained the grant of the whole of Natal and although he and his followers were treacherously slain immediately afterwards, their deaths were avenged and the Boer claim to Natal and the southern half of Zululand acknowledged in 1839. Pietermaritzburg was founded and a republic was set up and loosely federated to those already created at Winburg and Potchefstroom. But the Boers had thrust a wedge between the Zulus and Kaffirs. Soon the pressure from the north led them to draft Zulus into the lands south of the Umtamvuma river

claimed by the Kaffirs. The resulting pressure on the troubled eastern frontier prompted the British to occupy Port Natal in 1842 and to annex Natal three years later. Thus the Boer dreams of land and independence faded. Most of them trekked back to the plateau.

Meanwhile in Transorangia where most of the early trekkers had settled they were not in sole occupation of the land. Moshesh, the Basuto chief of

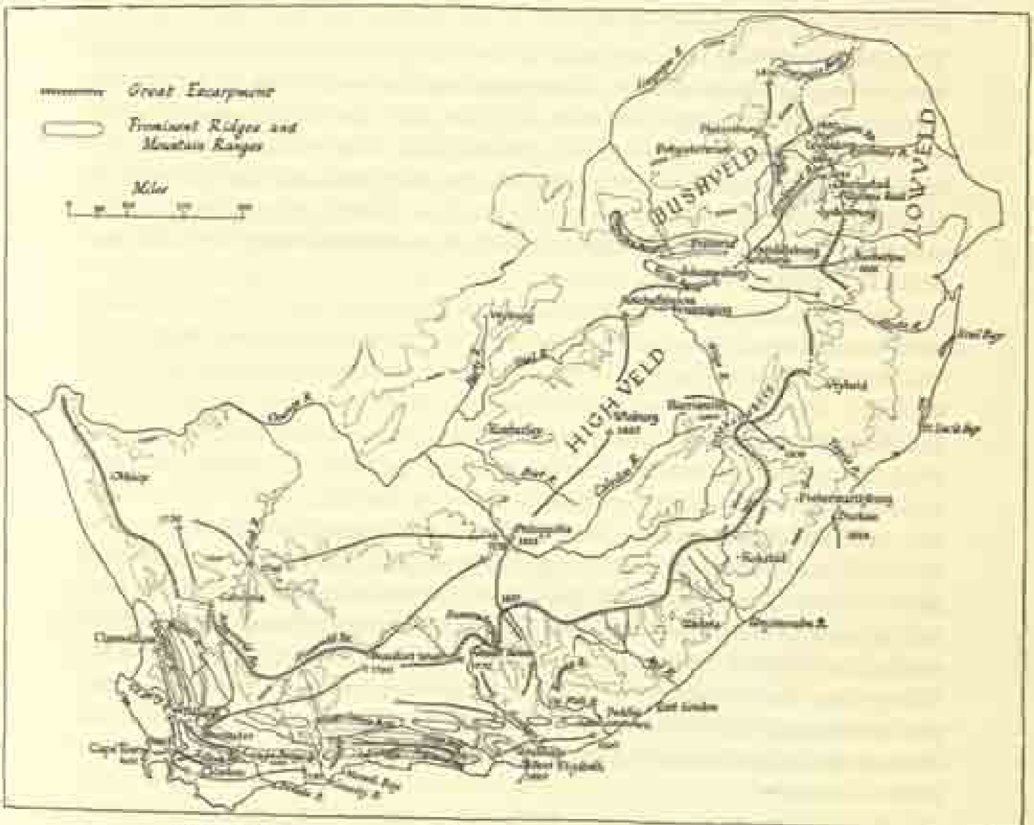


Fig. 41. The progress of European settlement in South Africa.

the mountains, claimed the fertile Caledon river lands (Plate 32), the Griquas the lands between the Orange and Riet rivers. Both would grant grazing rights but reserved their claim to ownership. The inevitable conflicts increased after the arrival of the Natal Boers, some of whom moved off and tried to settle the relatively dry western Transvaal. Finding conditions too uncertain, however, they then journeyed north-eastwards to found Ohrigstad, in the Steelpoort valley, and Leydsdorp between 1845 and 1846. But because of malaria the Ohrigstad settlement was soon forced to move to Lydenburg. Meanwhile the Transvaal

Boers, finding the winters particularly severe, had sought land in the more protected Bushveld and Lowveld. Some parties did reach the Limpopo, others Delagoa Bay, but most were either wiped out by hostile tribes, notably the Matabele, or depleted by disease.

The second period of rapid expansion was over. Henceforth European settlement was to be within the existing colonies.

From Trek to Independence 1846–48

The period following the occupation of the plateau grasslands was one of rapid increase in population and the Europeans, hitherto pastoralists, had to turn to crop production and a more intensive use of the land. On the Highveld and in the eastern Cape, however, the unreliable rainfall made crop production precarious. Covetous eyes naturally turned to the Caledon river lands and the valleys of the south-eastern Cape with their adequate summer rainfall and opportunities for irrigation. Geography indeed brought about the conflict between white and non-white in these areas.

In the south-eastern Cape the demand for land and trouble with the Kaffirs led to the extension of the colonial frontier to the Keiskamma river in 1844 and to the Great Kei river three years later. In the annexed area, known as British Kaffraria, however, reserves were set aside for the Bantu and European farms granted only around forts and mission stations. Thus the attempt at separating Black and White was abandoned in favour of settling them side by side, a change made inevitable by the large numbers of Bantu in this area.

In Transorangia conflicts between the races prompted its annexation as the Orange River Sovereignty in 1848; but the British Government, conscious of the great distances separating Cape Town from the lands beyond the Orange river and anxious to save the expenditure necessary for dealing effectively with the continuing troubles, gave independence to the Transvaal in 1852 and to the Orange Free State in 1854. Meanwhile the Cape Colony was granted representative government in 1852 and in 1856 Natal, which differed so greatly in its climate, agricultural opportunities and racial problems, was separated off as a Crown Colony.

In the years following these political settlements differing environmental conditions were largely responsible for the economic and social development of the colonies and republics along divergent lines.

West of the Great Fish river the European settlers had never had a major native problem with which to contend. The Bushmen had been little more than a nuisance. The Hottentots had never offered serious resistance and had declined greatly in numbers. Instead a shortage of labour had led to introduction of slaves and the development of an integrated society. In contrast beyond the Great Fish river the Bantu commanded the land. Here the trekkers were at first content with grants of land from the native chiefs whose authority they did not challenge. But with the European occupation of Natal and Kaffraria the position changed. Here

the Bantu could neither be ousted from the land nor absorbed into the European communities. The solution, perforce, had to be found in the setting aside of large native reserves and the development of separate Black and White communities. In the Transvaal the voortrekkers encountered only small and scattered tribes to whom they gave small and scattered locations to be held on good behaviour, without any security of tenure. Moreover, they regarded the Bantu as inferior beings, the children of Ham divinely appointed to be hewers of wood and drawers of water. Native policies dictated by racial distribution thus diverged in the various political units. Today the differences of attitude inherent in them are perpetuated in differing political and racial opinions between the several provinces.

A new problem arose in Natal where sugar cane proved the most successful crop but made heavy demands on labour. Since the Bantu had little agricultural skill and, in any case, could not be induced to leave their reserves, the settlers demanded indentured Indian coolies. Their demands were granted in 1860 and by 1865 there were 6,500 Indians working on the plantations. After five years these people were free to live and work where they wished and after a further five years were entitled to either a free passage home or Crown land of equivalent value. Most stayed, became market gardeners, fishermen or traders, multiplied greatly and now complicate the multi-racial problems of the country.

In the Border country the dense Bantu population meant large native reserves and little opportunity for European settlement. But the isolation of Natal and the commanding position of Moshesh in Basutoland prompted attempts to settle Europeans and loyal natives in the Transkei and so link Kaffraria and Natal. In 1857 the opportunity arising from the self-destruction of the Xosa and Tembu, who killed off their cattle and destroyed their crops in the belief that the spirits would then drive the white man into the sea and bring 'plenty' to their land, was used for the settlement of some 2,700 Germans and 3,200 other Europeans among the tribes between the Keiskamma and Great Kei rivers. Shortly afterwards the Griquas were persuaded to forsake their lands along the Orange river and settle around Kokstad.[17] This relieved one land problem in Transorangia, while in 1869 the ownership of the Caledon river lands was finally settled when, following war between Boer and Basuto, Britain intervened, proclaimed Basutoland British territory and divided the disputed lands equally between Black and White. Thus the commanding position of the Basutoland mountains resulted in the final triumph of Moshesh and the preservation of a Bantu state.

Meanwhile the Cape Colony enjoyed a period of prosperity and population growth. In 1854 there were 140,000 Europeans and 181,000 Non-Europeans; by 1865 the numbers were 210,000 and 315,000. The production and export of wool increased. Work began on a breakwater in Table Bay, railways were started from Cape Town to Wellington and Wynberg. But bad times followed; the Yorkshire weavers demanded long stapled wools instead of the 'Cape Shorts' and at the end

of the American Civil War the wool market collapsed. Meanwhile poverty gripped the Boer republics. Drought afflicted their farming activities and, handicapped by their interior location and remoteness from the ports, they were burdened by import duties imposed by the Cape and Natal.

At this stage mineral wealth, which was to dictate the next stage in the progress of settlement and alter the whole future of Southern Africa, was discovered.

Mineral Discoveries and the Growth of Population 1868–1910

The discovery of diamonds along the Orange and Vaal in 1868 and in the Kimberley district three years later opened a new chapter in the story of settlement in South Africa. It quickened the tempo of economic development, it brought a great influx of people and it led to new contacts and conflicts between Boer and Briton, European and Bantu.

The opening of the diamond fields brought prosperity both to the Cape and the neighbouring Orange Free State. People flocked to the diggings from all parts of the world. The farmers benefited from the market created by the mining population. Transport riding and trade flourished. Almost at once the trade of Cape Town increased and this despite the opening of the Suez Canal and the loss of the 'Eastern' traffic. Railways were quickly built inland from Cape Town, Port Elizabeth and East London, with each port anxious to get there first.[18] Another from Durban was projected. Docks were opened in Cape Town in 1870, the facilities at Port Elizabeth, East London, and Port Nolloth improved and efforts made to overcome the sandbar at Durban. Connexions with England became closer for now there was a weekly mail service and the run took only twenty-five days. These developments naturally drew the colonies and republics closer to one another and to Europe. But differing attitudes to the social problems arising from the contact of Black and White in Kimberley kept them apart. For the first time in South Africa all races came together in an urban area – Europeans from overseas, both Europeans and Non-Europeans from the Cape where there were equal civil and legal rights for all irrespective of colour, from Natal where the Bantu were treated differently, and from the Free State and Transvaal where the Europeans alone had rights. The Bantu came to provide cheap unskilled labour. Most came for short periods only and then returned to their kraals. The repercussions of this sudden coming together of races and peoples with vastly different cultural backgrounds were profound.

The developments on the diamond fields led the Transvaalers to enter the Lowveld and Bushveld. Gold was discovered in the Murchison range in 1870, near Pietersburg in 1871 and at Pilgrims Rest in 1873. In 1876 the Portuguese and Transvaal Governments proposed to build a railway to Delagoa Bay. But the difficult terrain, endemic malaria and horse-sickness, and the presence of the Bapedi tribe under Sekukuni restricted progress. Further south Cetewayo, King of the Zulus, was reviving the military discipline of Chaka and questioning the Swazi concession of land between the Tugela and Pongola rivers to the Transvaal.

When increasing suspicion between the miners and the Bapedi led to war in Sekukuniland in 1876 Britain, fearful of a general uprising further south, annexed the Transvaal. But trouble occurred on the eastern frontier. It was followed by a rebellion of the Zulus in 1877, then by that of the Basutos and finally by that of the Transvaalers. The wars were indecisive, but following the British rout at Majuba a settlement was reached in 1881 whereby the Transvaal was given self government and her boundaries defined; Swaziland was to be independent but the eastern districts were returned to the Transvaal. Peace was made with the Basutos who remained unsubdued in their mountain stronghold and in 1884 their land became a British Protectorate. Within a few years, however, the discovery of gold on the Witwatersrand and German ambitions in Africa altered the economic balance south of the Limpopo and hastened an extension of British influence.

So far settlement had taken place only on the eastern part of the plateau. To the west the intermittent streams, the increasing aridity and the poorer pasture discouraged people. This area had become the refuge of Bushmen and Hottentots who, however, suffered at the hands of the more powerful Bantu, particularly the Hereros. The area did, however, provide the route along which the missionaries passed to the interior of Africa. Farther west British influence was confined to Walvis Bay. When, however, Germany acquired the harbour of Angra Pequeira in 1883 and proclaimed a protectorate over South-West Africa the following year, fear lest Germany would unite this with the Transvaal and thereby cut the route from the Cape to the interior prompted British action. Bechuanaland Protectorate and the Crown Colony of British Bechuanaland were created in 1885 and the road to the interior secured. Meanwhile in 1884 St Lucia Bay was annexed to Natal and in 1886 Zululand taken over. The Cape Colony took over Walvis Bay and most of the Transkeian territories.

In 1886 gold was discovered on the Witwatersrand, an event which more than any other was to alter the distribution of population, and strain human relations in Southern Africa. The Transvaal, then the poorest state, suddenly became potentially the richest.

By reason of the nature and extent of the gold-bearing ores, power and machinery, miners and engineers and large numbers of unskilled Africans were required to develop the goldfield. European peoples of many different trades from many parts of the world flocked to the Witwatersrand. Africans were drawn from the reserves and before long from other African territories too. Railways were pushed inland from the ports to tap the developing area and carry to it imported machinery and supplies. Others were built from the goldfield to the East Rand coalfield which was developed to provide the much needed coal.

With their cherished independence threatened by events on the Witwatersrand some of the Boer farmers began to occupy western Swaziland. Others looked to the grasslands beyond the Limpopo. Once again the repetition of closer settlement followed by expansion beyond existing bounds seemed likely but

north of the Limpopo the Boers were forestalled by Cecil Rhodes, who secured mineral concessions in Matabeleland in 1888. Two years later the grasslands of Mashonaland were occupied and in 1893 following war with the Matabele their territory was taken over and the route for Rhodes dreamed-of Cape-to-Cairo railway secured. Rhodes' ambition was the federation of all the South African states into what would have been a natural geographical unit. But the Boer farmers, reared in isolation and wedded to the land bravely occupied in face of the unknown, felt their cherished independence threatened by the rapidly growing population of the Rand, a population mainly British, cosmopolitan, intent on industry and commerce, dependent on African labour. The British felt frustrated by Boer restraints and resented the long qualification period for the franchise. Mutual distrust increased, fanned the Jameson Raid of 1895 and culminated in the Anglo-Boer war of 1899–1901, which was to carry such bitter feelings into the future. At its end the republics gave up their independence and became Crown Colonies and in 1903 a customs union was effected between the four colonies, Southern Rhodesia and the native protectorates; and all tariff walls between them were swept away.

The war had repercussions on the attitude of the natives, who were less willing to work in the mines. To alleviate the labour shortage, Chinese coolies were imported in 1905 but, although hard working, they caused so much trouble that nearly all of them were repatriated by 1908. A few, however, remained in Johannesburg where they became market gardeners.

More serious, however, was the growing problems of the Indians, few of whom had returned to India. Most had become market gardeners or fishermen, but the Witwatersrand had attracted many as traders. Their low standard of living, the filth and squalor of their quarters and their oriental business methods, however, soon threatened to undermine European standards and exploit native weaknesses. The outbreak of plague in their quarters in Johannesburg prompted a suggestion from the British Government that on sanitary grounds they should be confined in locations. Meanwhile the Transvaal tried to exclude them and Natal to stiffen her laws against them. Their case, however, was taken up by a well-to-do Indian barrister in Johannesburg, Gandhi, who aroused the interest of the Government of India. The difficulties of dealing with an external power on internal matters was one of the factors which hastened the coming together of the colonies in the Union of South Africa in 1910. The Protectorates remained outside, but provision was made for their transfer under certain conditions at a later date.

Closer Settlement and a Changing Economy 1910 Onwards

At the time of Union, South Africa was a poor under-developed country. Except on the sugar cane estates of Natal and the wine farms in the Cape the agriculture carried on both by Europeans and by Non-Europeans was largely of a subsistence nature, and dominated by cattle rearing. Gold and diamond mining were the only

important extractive industries and foreign interests had been very largely responsible for their development. Manufacturing industries hardly existed. Trunk railways had been built from the ports to the Witwatersrand but there was no network to serve the other parts of the country. The port facilities were poor.

Both the European and Non-European sections of the population were increasing rapidly and the allocation of land between them was the most pressing problem confronting the new country. Practically all the land to the Limpopo was already occupied. Closer settlement was inevitable. The Europeans occupied 90 per cent of the total land area of the country but they hungered for more. For over the greater part of the plateau the low and erratic rainfall permitted pastoral activities but made crop production precarious. As the Boer families multiplied there were now no new lands for them to occupy and the division of the existing farms carried the risk of failure. Already there were many landless 'Poor Whites'. The Bantu were pent up in the reserves in the south-eastern Cape and Natal. Although occupying some of the better watered parts of the country they had too little land for their needs. Between the several provinces the laws governing the purchase of land by them varied. In the Cape and Natal they were entitled either individually or corporately to buy land and indeed in the latter province had purchased a block between the Tugela and Buffalo rivers and the Drakensberg. In the Transvaal and the Orange Free State they could not acquire land in freehold and the reserves allotted to them were very small; most lived on Crown lands or on European farms in return for providing labour. In face of the demands for more land by both European and Bantu an attempt was made to regularize the position by the passing of the Native Lands Act in 1913. This effected a *status quo* between European and Bantu in land ownership, but, recognizing that the existing Bantu-owned areas were too small, provided for the appointment of a commission to mark out additional areas for Native purchase. Thus the territorial segregation between the two dominant races in the country became fixed. The commission reported in 1916 but it was not until 1936, when the Native Trust and Land Act was passed, that provision was made for 'Released Areas' (i.e. released from the terms of the 1913 Act) within which land could be bought either by individual natives or by the South African Native Trust – a body set up to administer Parliamentary grants and other revenues for the purchase of land up to a total of 7¼ million morgen or 15¼ million acres for the Bantu.

The 1913 Native Lands Act meant that in future both Europeans and Non-Europeans would have to accommodate their increase on the lands already held by them. To this challenge the two sections of the population have reacted in different ways. The story of the great economic developments of the past fifty years is very largely the story of the answer to this challenge. Backed by political power, owning large areas of land, able to acquire technical skills and aided by an inflow of money from overseas the Europeans have put their agriculture on a commercial basis and put their land to more intensive use. They have opened up the enormous mineral resources of the country and developed a range of modern

industries. New railways and roads have been built and modern port facilities provided. Meanwhile the Bantu, lacking financial and technical resources, have continued their traditional agriculture in their Reserves, which, in the absence of industrial development, have been unable to support the increasing population. So along with Indian and coloured people the Bantu have poured into the European towns to work on the mines and in the industries of the White Man. This stream of Non-Europeans into the towns has, however, given rise to major problems (see chs. 25 and 42) and prompted legislation to ensure racial segregation within the urban areas. Thus the Urban Areas Act of 1923 empowered municipalities to set aside locations for the Non-European people and, outside the Cape, made provision for a uniform pass law in order to control their movement. The 1950 Group Areas Act extended the process.

The half-century since Union has witnessed tremendous economic developments in South Africa, which from being one of the poorest countries in the world has become one of the richest. At the same time it has seen the growth of some of the most difficult racial problems in the world.

This account of South Africa therefore must proceed to an examination of the great developments in agriculture, and in mining and manufacturing industry; of the provision of water supplies and irrigation; and of the extension of communications and the growth of trade. In all these developments the Europeans have been the motivating force: the Non-Europeans have provided the bulk of the labour.

The Bantu Reserves, both in the Union and the Protectorates, and the Bantu economy must be considered separately.

BIBLIOGRAPHY

1. See P. SERTON. *Die Zeilweg om die Kaap*. Die Huisgenoot, June 1922. Cape Town.
2. See MARGARET MARSHALL. *The Growth and Development of Cape Town*. M.A. Thesis, University of Cape Town. 1944 (unpublished).
3. See GERHARD SCHOTT. *Geographie des Atlantischen Ozeans*. Hamburg. 1926.
4. See G. M. THEAL. *A History of South Africa 1486–1691*. London. 1888.
5. ERIC A. WALKER. *A History of South Africa*, London, 1928. From which much of the information in this chapter has been obtained.
6. See C. M. van den HEEVER and P. de V. PIENAAR (ed.). *Kultuurgeskiedenis van die Afrikaner*, Deel 1, Nasionale Pers, Kaapstad. 1945.
7. See 'The origin and incidence of miscegenation at the Cape during the East India Company's régime 1652–1795', in *Race Relations J.*, Vol. xx, 1953, pp. 23–7.
8. E. E. MOSSOP. *Old Cape Highways*. Cape Town. Contains much information relating to the early routes.

9. See C. GRAHAM BOTHA. 'The dispersion of the stock farmer in Cape Colony in the eighteenth century'. *S.A.J.Sc.*, Vol. XX, 1923, pp. 524–80.

10. See P. C. CLARK. 'Geography and settlement in South Africa and Australia'. *S.A.G.J.*, Vol. XIII, 1930, pp. 17–46.

11. See C. W. de KIEWIET. *A History of South Africa*. O.U.P. Oxford, 1941. This is the most readable history of South Africa.

12. See L. E. EDWARDS. *The 1820 Settlers in South Africa*. London. 1934.

13. See H. E. HOCKLY. *The Story of the 1820 Settlers in South Africa*. Cape Town. 1948.

14. See E. A. WALKER. *The Great Trek*. London. 1934.

15. See W. PUNT. 'Geographical influence on the Great Trek and Later'. *S.A.G.J.*, Vol. XIV, 1931.

16. See MANFRED NATHAN. *The Voortrekkers of South Africa*. 1937.

17. See W. M. MACMILLAN. *Bantu, Boer and Briton*. London. 1929.

18. See D. M. GOODFELLOW. *A Modern Economic History of South Africa*. London. 1931.

19. ERIC A. WALKER. *The Frontier Tradition in South Africa*. Lecture delivered before the University of Oxford, 5 March 1930. O.U.P. 1930.

Water Supply and Irrigation

7

Water Supply and Irrigation

Introduction

Largely because of the low and unreliable nature of the rainfall, surface water is scarce over the greater part of South Africa. In the early days the presence of water fit for drinking purposes largely dictated the course of settlement both by Bantu and European; today the provision of reliable supplies of water is of vital importance not only for domestic consumption but for agricultural, mining and industrial development. Two main sources of water are available – the perennial rivers whose flow is conserved where possible by means of storage dams, and underground supplies which are tapped by means of boreholes. Each source must be considered separately. Brief attention, however, must be given first to the growing demands for water which have necessitated the construction of large storage reservoirs calling for Government assistance and expenditure.

Until the latter part of the nineteenth century the population was small and dispersed. Water for domestic purposes was obtained locally, in the coastal regions of the Cape from a mountain stream, in the interior from a spring or 'fontein'. Irrigation, started by the first European settlers, was practised in the valleys of the south-western and southern Cape. Water was plentiful, methods simple. The individual farmers might build small division weirs and furrows, others simply allowed the flood waters to pass before sowing their seeds in the wet soil. Towards the end of the nineteenth century the picture began to change. As the population increased and the land was more intensively used the need arose for utilizing the major rivers of the Cape for irrigation purposes. As this involved the construction of large weirs serving several farms, however, legislation was required. Apart from small division weirs little was accomplished before Union, partly because of the difficulties and expense involved in the construction of big schemes, partly because of the innumerable vested interests created by the laws governing irrigation and water rights in the various provinces.

Two years after Union the Irrigation and Conservation of Water Act removed some of the difficulties and paved the way for larger scale irrigation

projects. It provided for general control over the water resources of the country and established machinery for the constitution of irrigation districts and boards. By 1922 ninety-two boards had been set up. By 1951 the number had risen to one hundred and fifty-five, ninety-four of them in the Cape and fifty-two in the Transvaal. Between 1913 and 1928 a number of irrigation projects were undertaken by the boards with the aid of loans from the Government (Fig. 42) but the difficulties experienced with both the construction and maintenance of the works and with farming practices led the Government to question the wisdom of such undertakings. A halt was called. But soon afterwards the country suffered a severe and prolonged drought and the Great Depression broke over the world. The Government then began irrigation works as relief measures and gradually became committed to a number of large schemes. This activity continued until the outbreak of the 1939–45 war when only maintenance work was effected. On the cessation of hostilities, however, work recommenced on uncompleted schemes and began on a number of new ones. During recent years increasing Government assistance has also been given in the provision of boreholes to supply water for domestic and agricultural use.

Most of the Government conservation schemes have been concerned essentially with the provision of water for irrigation.[1] During the present century, however, the growth of towns and of mining and manufacturing has brought increasing demands for urban water. Responsibility for its provision has generally rested with the individual municipalities, but for a quarter of a century the Government has been concerned with schemes on the Vaal river providing water for urban use on the Rand as well as for irrigation downstream. Since 1945 it has been responsible for the supply of water to the fishing settlements and factories on Saldanha Bay and in the future it may be expected to play an increasingly important role in the provision of the nation's various water needs – domestic, agricultural, and industrial. During the past twenty years, the annual Government expenditure on water conservation and borehole services has increased very rapidly, in 1954–5 approaching £8 million, nearly five times the 1938–9 figure (Fig. 42). Even greater expenditure must be expected in the future.

Underground Water

As perennial streams are, with the exception of the major rivers, rarely found outside the mountain and coastal belts of the south-western and southern Cape, underground supplies of water are extremely important over the greater part of South Africa. Indeed over most of the interior settlement has been made possible only by the borehole. In 1948 there were about a quarter of a million boreholes in the Union yielding between them a maximum of 1½ billion gallons of water.[2] New boreholes were being sunk at the rate of about 7,000 annually. But according to figures given in the agricultural census for 1949–50, of the 218,000 boreholes on European farms, 73,000 were either dry or capable of yielding less than 60 gallons an hour, while only 36,000 gave more than 1,000 gallons an hour.[3]

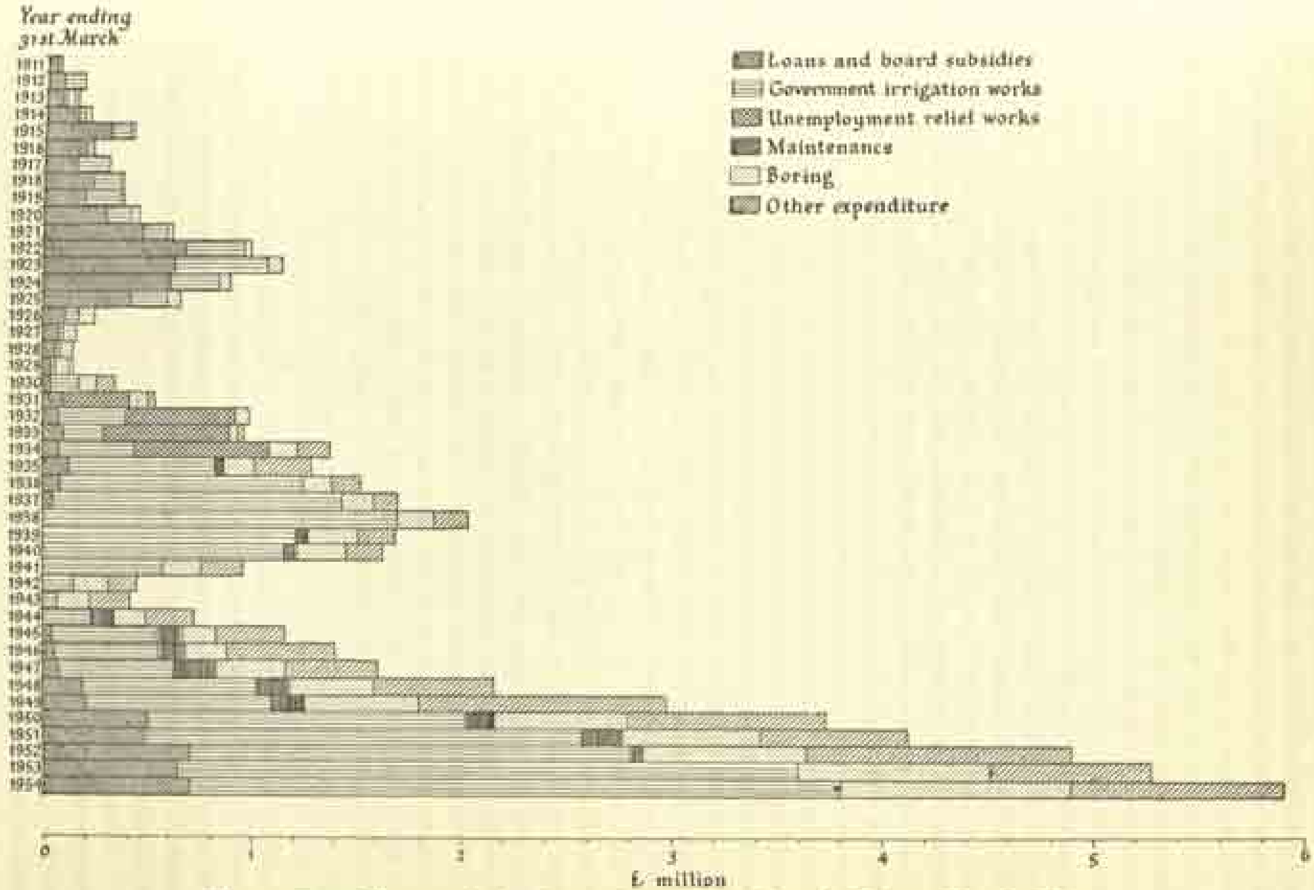


Fig. 42. Expenditure on irrigation and water supply in the Union of South Africa.

(Compiled from data given in the annual reports of the Director of Irrigation.)

Nevertheless, about one-half of the 2½ million people living on farms depended on borehole water for domestic use and watering stock. In the drier parts of the country the railways depended on boreholes for locomotive water and on the Witwatersrand, where boreholes made possible the early development of the mining industry, they still contributed an important share of the water used for domestic and industrial purposes.

Although boreholes contribute such an important share of the country's water supplies, large artesian basins are lacking, the nature and disposition of the rocks over the greater part of the country being unfavourable. The Great Karoo and the Springbok Flats possess the requisite structure (see ch. 1) but in the former the sandstones of the Beaufort and Stormberg series have a low porosity and, furthermore, are intersected by innumerable dolerite intrusions which act as barriers to the underground circulation; and in the latter the intake area is limited, the beds are not very permeable and concealed ridges and faults interrupt the movement of water along the bottom of the basin. Artesian supplies of water occur only in basins of very limited extent in the Karoo beds of the Gibeon district of South-West Africa, in the crystalline rocks of Namaqualand and in the valleys of the Sundays, Coega and Zwartkops rivers in the south-eastern Cape; and in the last mentioned area the water is very brackish.

Apart from their effect on artesian supplies the igneous intrusions have further deleterious effects on water supplies. Since they interrupt the normal underground movement their widespread occurrence over the South African plateau means that the amount of underground water available in any area depends in the first instance upon the rainfall so that supplies are most plentiful in the east and diminish towards the west where they are most needed. Furthermore replenishment takes place more slowly in the west where the amount drawn must be regulated if the exhaustion of supplies is to be avoided.

Because of the above factors the quantity and quality of water won from boreholes depends very much on the local geological conditions and particularly the nature of the yielding formation, its relationship to other strata and to intrusions and faults. The only porous rock formations in the Union are some of the sandstones in the Cretaceous beds, the weathered sandstones in the Karoo system and the weathered portions of crystalline rocks.[4] Elsewhere underground water occurs only in cracks and fissures in the rocks. Everywhere water is most likely to be found at the junction of permeable and impermeable rocks and at the contact between intrusive igneous dykes and the country rock. Crush zones in igneous rocks and faulted structures in all rocks are also usually favourable.

Three geological formations are outstanding as aquifers – the lavas of the Ventersdorp System, the Dolomite and the quartzites and shales of the Pretoria Series of the Transvaal system, and the map showing the distribution of boreholes shows a concentration in the south-western Transvaal (Fig. 43) where their outcrops are most extensive (see Fig. 2). The favourable water-bearing properties

of the Ventersdorp lavas result from their very high porosity and from the facilities for downward percolation created by the fact that they consist of a large number of thin volcanic outpourings of differing texture and hardness between each of which surfaces of broken continuity occur. Boring is easy, water is reached at shallow depths and yields averaging 20,000 gallons per day and ranging up to 100,000 gallons per day are obtained. Many of the larger buildings in Johannesburg as well as a large number of farms in the western Transvaal obtain their water from this source.

The Dolomite, notable for its many springs or eyes from which all the larger rivers of the Transvaal are fed, gives higher yields from boreholes than any other formation but owing to the fact that the water is localized in caverns and fissures it is difficult to find and many boreholes fail. The best results are obtained in the southern Transvaal where the disposition of the rocks and the relief features are exceptionally favourable. Here the Dolomite occupies the lower ground and gathers the surface run-off from the ridges of the Witwatersrand and Pretoria quartzites as well as from the high granitic areas. Daily yields average rather less than 40,000 gallons but they often exceed 100,000 gallons from boreholes less than 100 feet deep. South and south-west of Johannesburg exceptional yields are obtained at the Zwartkopjes and Zuurbekom pumping stations supplying the Rand Water Board (see p. 150), daily maxima of 5·65 million gallons and 6 million gallons respectively being derived from boreholes. In the western Transvaal conditions are more chancy owing to the presence of interbedded chert and the incidence of metamorphism. Failures are as high as 50 per cent while water is seldom reached above a depth of 150 to 200 feet. On the Kaap plateau supplies are more certain but the yield – averaging 25,000 gallons per day – is lower. Everywhere the largest supplies are obtained in proximity to faults and intrusive dykes and sills which break the circulation. In the Cape the rocks of equivalent age in the Malmesbury Series consist mainly of shales and crystalline limestones which yield water only near the foot of the Cape ranges where there is an appreciable run-off from the mountains.

The disposition of the alternating quartzites and shales of the Pretoria Series dipping gently inwards towards the centre of the Bushveld basin is highly favourable for the infiltration of water particularly in the western Transvaal where the quartzite outcrops attain their greatest width. In this direction metamorphism emanating from the Bushveld lopolith appears to have improved the water carrying capacities of the formations in an area of lower rainfall. Throughout the belt both the quartzites and shales yield good supplies of water and borehole failures are rare. In addition numerous springs are thrown out at the junction of the quartzites and shales.

In the southern Transvaal the rocks of the Witwatersrand System, more steeply inclined but in their nature and succession resembling those of the Pretoria Series, also yield excellent quantities of almost pure water. Yields of over 100,000 gallons per day are sometimes obtained from shallow boreholes while at

depths of between 2,000 and 6,000 feet flows averaging as much as 4½ million gallons have been encountered by the gold mines on the East Rand where the strata is overlain by the Dolomite. In this area the water resources of the Witwatersrand rocks are utilized mainly by industrial concerns, particularly breweries and mineral water factories which appreciate the quality of the water. In other parts of the country the rocks are more compact and are poor aquifers.

The concentration of water-bearing formations in the southern and south-western Transvaal is very marked. Elsewhere conditions are much less favourable. In the northern and eastern Transvaal crystalline rocks, mainly granite and diabase, yield good supplies where the surface material is so thoroughly decomposed that it acts as a sponge and where intrusive dykes dam up the underground flow. Near Johannesburg schists in the Old Granite give good supplies but this is largely because they catch the run-off from the ridge of Orange Grove quartzite (Witwatersrand System). Even where conditions are favourable, however, about one-third of the boreholes fail to find water while in the western Transvaal, where similar rocks occur, the percentage of failures exceeds 50 per cent. In the Cape Folded Belt the geological conditions are unfavourable for the accumulation of underground water but innumerable springs issue at the contact of the Table Mountain Sandstone and the Bokkeveld shale and many streams cross the valleys and basins. Underground water may be obtained from the Bokkeveld shale even in the more arid valleys but it is generally very brackish. In the Karoo, where underground sources frequently provide the only supplies of water, conditions are most favourable in the south-west where the Dwyka beds, fractured and fissured by the Cape orogeny, carry good supplies locally. Elsewhere water may be obtained from the Ecca beds but the amount depends very much on the tilting or folding of the rocks and on the presence of dykes, and in many cases, especially where there is a cover of Kalahari sand, the water is saline. Ironically the Karoo rocks yield the most reliable supplies of water not in the Karoo itself but on the northern Highveld where the sandstones and shales of Ecca age are water bearing.

Over much of South Africa the quality of underground water, which depends both on the climatic conditions and on the nature of the water-bearing rocks, leaves much to be desired. Broadly speaking over the western part of the interior, where the rainfall is less than 15 inches and there is often total dependence on underground sources of water, the water is generally saline (Fig. 43). Where the rainfall exceeds 15 inches over the eastern half of the country and in the southern coastal areas the quality of the borehole water, while varying with the nature of the water-bearing rocks, is generally reasonably fresh and is satisfactory, in some cases after suitable treatment, for most purposes.

Over most of the Cape and in the coastal belt of Zululand borehole water is so highly saline (being highly mineralized chloride-sulphate waters with over 100 parts total solids per 10^5)[8] that its consumption over a long period is dangerous to the health of both man and beast. Indeed in the more arid regions of the

Union of South Africa and South-West Africa not only do human beings suffer damage to their health (through intestinal and urinary disorders) and teeth (through caries) as a result of drinking saline and hard waters but stock losses are so heavy that many of them have 'a severe struggle to make stock farming a payable proposition and frequently fail to do so'.[7] In these areas the collection of

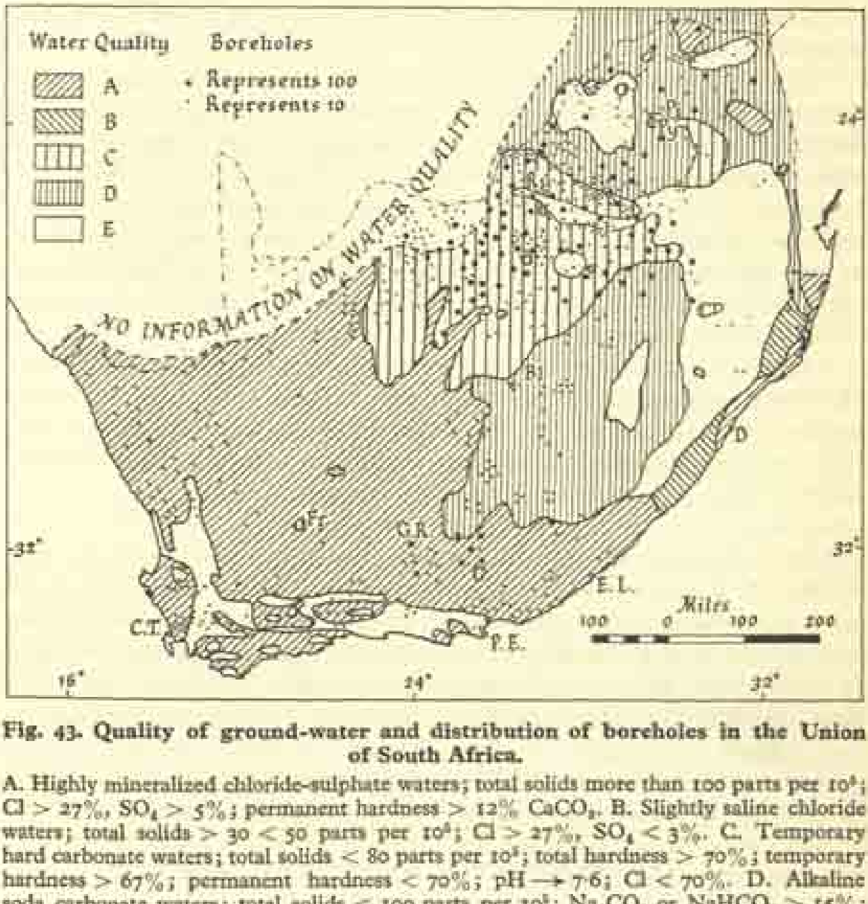


Fig. 43. Quality of ground-water and distribution of boreholes in the Union of South Africa.

A. Highly mineralized chloride-sulphate waters; total solids more than 100 parts per 10^5; $Cl > 27\%$, $SO_4 > 5\%$; permanent hardness $> 12\%$ $CaCO_3$. B. Slightly saline chloride waters; total solids $> 30 < 50$ parts per 10^5; $Cl > 27\%$, $SO_4 < 3\%$. C. Temporary hard carbonate waters; total solids < 80 parts per 10^5; total hardness $> 70\%$; temporary hardness $> 67\%$; permanent hardness $< 70\%$; $pH \rightarrow 7{\cdot}6$; $Cl < 70\%$. D. Alkaline soda carbonate waters; total solids < 100 parts per 10^5; Na_2CO_3 or $NaHCO_3 > 15\%$; permanent hardness nil. E. Pure waters; total solids < 15 parts per 10^5; $pH < 7{\cdot}1$.

(Quality of water after G. W. Bond; boreholes after H. F. Frommurze.)

rain-water for drinking purposes, preferably Moorish fashion in cisterns beneath the houses, and the conservation of surface water in small dams for watering stock, offer the only possibilities of safe water supplies.

In the eastern coastal belt boreholes yield slightly saline chloride waters, which can be safely used for all domestic and agricultural purposes and for most

industries. They require softening with lime and soda, however, when used in boilers for steam raising purposes.

In the southern Transvaal and adjoining parts of the Cape and Free State, Dolomite, the Ventersdorp lava, the Pretoria shales and the basic rocks of the Bushveld Igneous Complex yield temporary hard carbonate waters. Fortunately with suitable softening treatment these waters may be used for almost all purposes, except for brewing, for they constitute the most important underground resources in the Union.

In the northern Transvaal, the Old Granite, the Bushveld granite and the Pilansberg rocks and in the eastern Free State and the adjoining parts of the Cape, Natal and Basutoland, the Beaufort and Stormberg rocks yield waters classified as alkali-soda-carbonate waters. These contain less than 100 parts per 10^5 of total solids and are generally satisfactory for domestic purposes; some of them, however, have relatively high contents of sodium carbonate (in some cases above 35 parts per 10^6) and if used for irrigation may be damaging to soil structure and injurious to plant life. They are suitable, after softening, for most industrial purposes other than brewing and tanning.

The purest waters come from the sandstones and quartzites and from the Old Granite in the wetter parts of the country. In some cases the waters may be acid, e.g. the pH of some of the waters from the Table Mountain Sandstone may be 4·5, but this is readily counteracted by the addition of a little lime. Generally speaking these waters are suitable for all domestic, agricultural and industrial purposes.

The importance of underground water in South Africa may be gauged from the fact that at present boreholes furnish three times more water than the thirty-seven major conservation schemes in the Union. But in recent years the water level appears to have been falling in many boreholes, suggesting that more water is being drawn than can be replenished by rainfall. Whether or not this is associated with long term variations of rainfall or with the disturbance of the vegetative cover leading to a reduction in the amount of water percolating underground, the position is one of serious national concern calling for investigations and, if necessary, restrictive measures over the abstraction of water.

The Conservation of Water for Irrigation

Because of adverse physical conditions, sites for storage reservoirs and opportunities for irrigation are limited in South Africa. Due to the long continued uplift of the subcontinent the major rivers are entrenched in deep gorges and large alluvial plains are lacking. As a result of the Tertiary warpings (see ch. 1) the gradients of many of the rivers in their lower courses are often so steep that excessively high dam walls would be necessary to give an adequate storage, while in their upper courses the gradients are so slight that the imposition of a barrage would flood considerable areas upstream.

The regime of the rivers is a further drawback. There are no snowfields or

glaciers to feed the major rivers, no natural lakes or forests to regulate the flow. In most areas river flow depends almost entirely on the erratic rainfall and is subject to extreme fluctuations, both annually and seasonally (Figs. 44–6). In many cases these fluctuations are so great that in order to guarantee irrigation water, provision must be made for drought periods of two or three years. In many

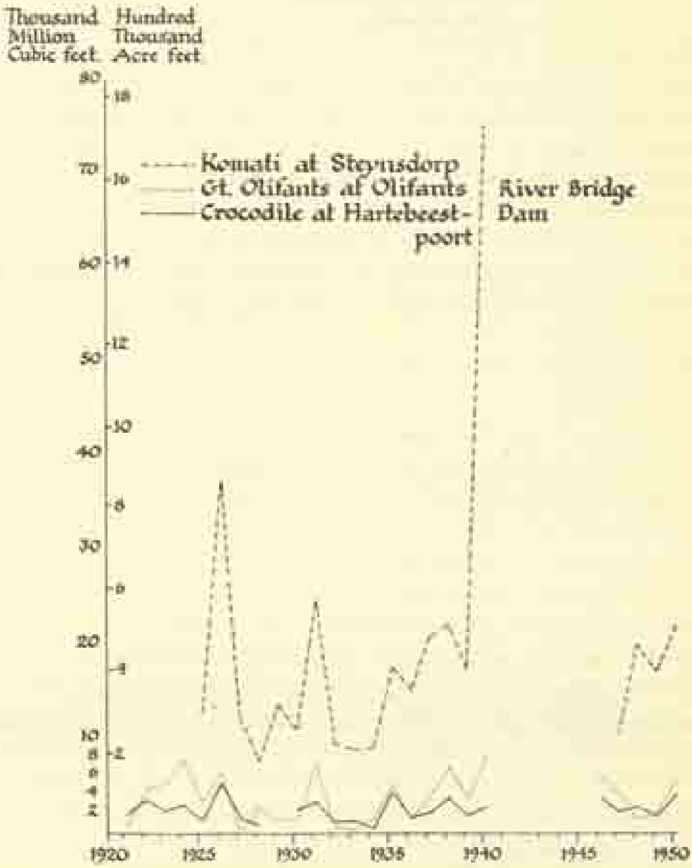


Fig. 44. Annual discharge, Limpopo and Crocodile-Komati river systems.
(Compiled from data given in the annual reports of the Director of Irrigation.)

instances the maximum annual run-off is three times the normal while during severe droughts the rivers may be almost dry throughout the year. Further difficulties arise from the load carried by most rivers in suspension and solution. Frequently the average silt load exceeds 2 per cent and, as most of this is dropped when the velocity is checked by dam walls, reservoirs rapidly silt up unless de-silting works or special sluice gates are provided. High concentrations of alkalis in irrigation water are a further problem, particularly where the streams have passed

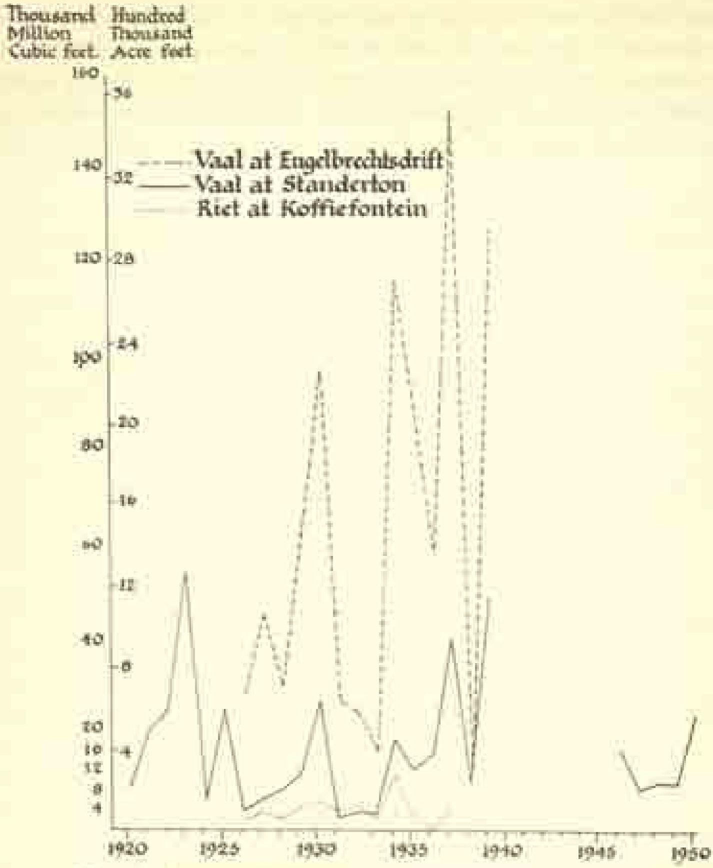


Fig. 45. Annual discharge Orange-Vaal river system.
(Compiled from data given in the annual reports of the Director of Irrigation.)

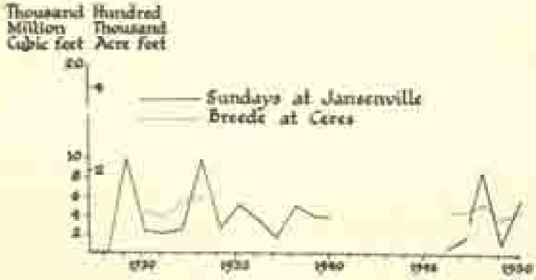


Fig. 46. Annual discharge, Sundays and Breede rivers.
(Compiled from data given in the annual reports of the Director of Irrigation.)

over Karoo shales and dolerite, which are rich in sodium carbonates, and the storage dams are located in arid country where evaporation is excessive.

Because of these features the provision of adequate healthy irrigation is difficult and costly. The opportunities vary greatly from one region to another and from one drainage basin to another.

The Orange-Vaal River Basin

The Orange river carries the largest volume of any South African river and on its long journey from the Drakensberg to the Atlantic Ocean traverses vast stretches of arid country but, unhappily, the opportunities for irrigation along its course are extremely limited.

There are several reasons for this. Firstly because of the highly seasonal and erratic nature of the rainfall in the Drakensberg, where its headstreams rise, the volume of the river fluctuates enormously; heavy rains may be followed by disastrous floods while after exceptionally long dry periods the river may cease to flow in the lower valley. Any storage works are therefore necessarily very costly.

More serious is the nature of the Orange river valley and its relationship to its tributary valleys [8, 9]. For most of its course the river traverses denuded plateau country in which it has become deeply entrenched below the surface. Where it crosses the Griqualand-Transvaal axis of uplift its gorge is particularly deep and rugged. In the Drakensberg the headstreams of the Orange remove vast quantities of material from the surface. The main river carries a heavy silt load but only occasionally where resistant rocks have imposed a local base level has any deposition occurred and then only in the form of narrow strips, patches or islands of alluvium, liable to submergence during floods. Even today most of the material eroded from the catchment area is carried to the sea. There are more extensive alluvial deposits in the upper valleys of the Hartebeest, Zak, and Brak tributaries, but these streams are intermittent; for perennial irrigation, water would have to be brought from the Orange river. This, however, is not practicable for owing to the relationship of each river to the Griqualand-Transvaal upwarp, the upper valleys of these tributaries lie at much higher levels than the Orange river; and to get a sufficient gradient in the main canals the diversion would have to be so far up the Orange that canals to the Hartebeest and Zak valleys would be more than 1,000 miles long and to the Brak valley over 500 miles long; the loss of water by evaporation would be enormous and little would ever reach the irrigible areas; moreover the cost would be prohibitive.

Along the Zak, Hartebeest and Brak rivers only flood irrigation is practised. The alluvial lands are divided by earth walls into basins or 'saaidams', which are irrigated in turn by the passing flood waters. Crops of wheat, sown in the wet soil, are then raised.

Along the Orange river itself several small schemes and one of medium size have been possible [10]. These began as flood irrigation schemes towards the end of

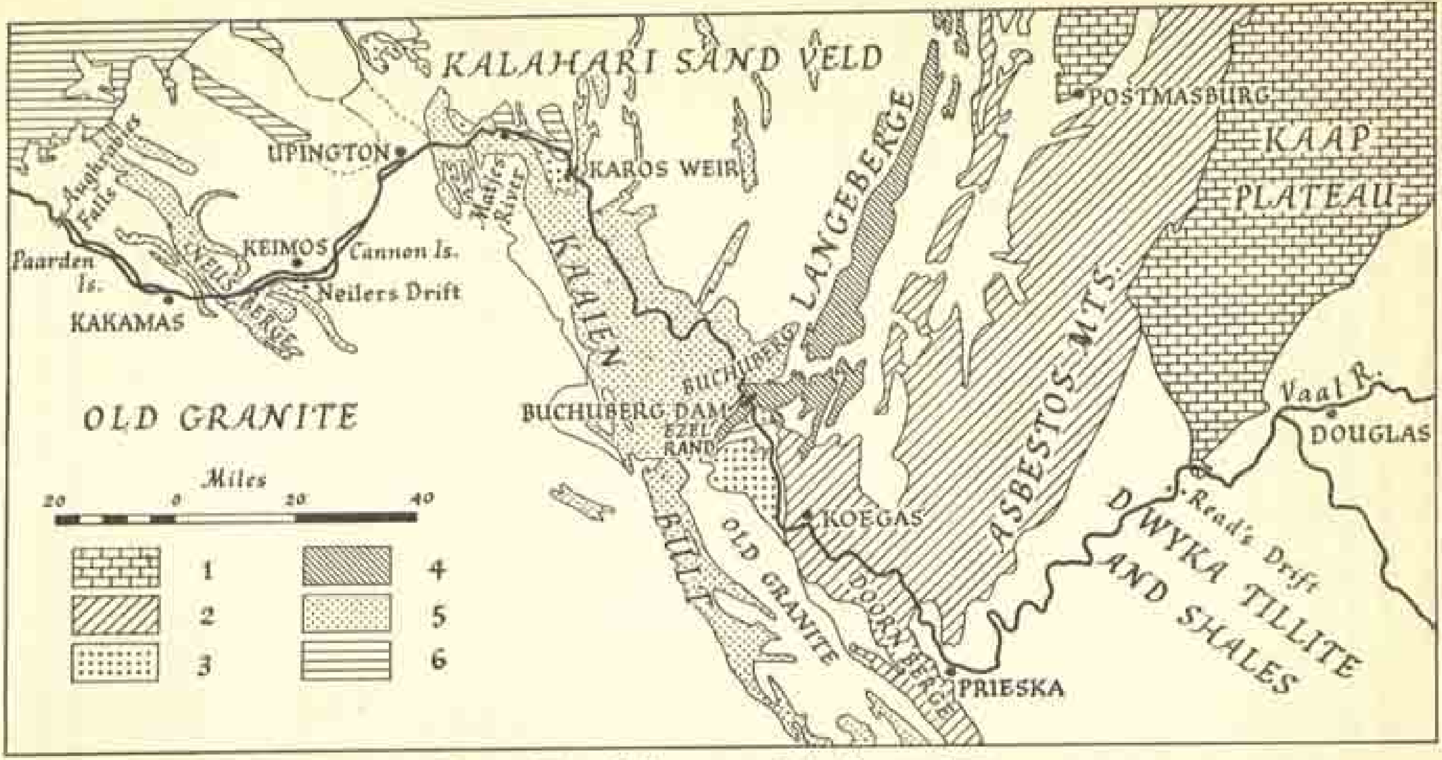


Fig. 47. The middle course of the Orange river.

1. Dolomite of the Kaap plateau. 2. Griquatown = Pretoria Series – mainly banded ironstones and slates. 3. Black Reef Series – quartzite. 4. Matsap Series—quartzites and sandstones. 5. Kaaien beds (Kheis System), mainly quartzites and schists. 6. Nama System. The Buchuberg dam and Karos weir irrigate the alluvial terraces on the left bank of the river downstream as far as Matjes River. Below Upington irrigated land occurs on the right bank of the river as far as Kakamas and on the left bank nearly to the Aughrabies falls.

the nineteenth century. They are located below Upington where, in crossing the Old Granite, the river braids and encloses a number of islands varying in size from 8 by 1½ miles to small silt mounds (Fig. 47). The islands suffer to varying degrees from submergence during floods but the suitability of the larger ones for agriculture together with the opportunities for the diversion of water at Neus, where the river narrows and falls some 34 feet in less than a mile, encouraged the Dutch Reformed Church to found a colony at Kakamas in 1898 for farmers rendered destitute by the drought of 1896 and rinderpest of 1897. Gradually these settlers brought about 5,000 acres under irrigation. At about the same time a group of private farmers brought a similar acreage under irrigation at Keimos. The fortunes of these and other farmers growing crops under irrigation along the Orange river valley, however, fluctuated with the variations in the river flow and in years of drought distress was acute. Partly to provide a more reliable water supply for these farmers and partly to support a settlement of 'Poor Whites' on the alluvial lands above Upington, in 1929 the Government undertook the construction of a storage reservoir at Buchuberg[11] where the Orange river crosses the Griqualand-Transvaal upwarp and was readily dammed in the deep gorge it had cut through the Matsap quartzites (see Fig. 47). Completed in 1934, the dam had an initial storage capacity of 29,000 acre feet, but despite the provision of special sluice gates this has been considerably reduced by siltation. Nevertheless in years of very low flow the dam does assure at least one good watering for all the irrigated land, totalling nearly 40,000 acres, between Upington and the Aughrabies falls. Because of the isolation of the area the farmers concentrate on non-perishable products – lucerne, cotton, wheat, sultanas, and other dried fruits.

Above Prieska the slight gradient of the Orange river consequent on the relative depression of the Karoo-Basutoland area in Tertiary times precludes large scale irrigation schemes. There is a small scheme serving the area around Douglas but attempts to find sites for dams which would bring the alluvial lands between the Orange-Caledon confluence and Bethulie and between the Orange-Vaal confluence and Prieska under irrigation have proved fruitless.

Thus the area irrigated from the greatest river in the country is extremely small.

The Vaal river rises at an altitude of about 5,600 feet in the level plateau country characterized by indeterminate drainage and numerous pans, near Lake Chrissie. Its catchment area contrasts sharply with that of the Orange, but the river has similar drawbacks, including a fluctuating volume and a heavy silt load. A combination of favourable circumstances has, however, led to the construction of the second largest water storage scheme in the southern hemisphere along its course.

Initiated on a surface of relatively soft Karoo rocks (see ch. 1, p. 20 and ch 41, p. 611) the Vaal river has, in places, become superimposed on the more resistant pre-Cambrian formations below; where highly resistant rocks cross the valley, e.g. just below the confluence of the Wilge, at Parys, Fourteen Streams,

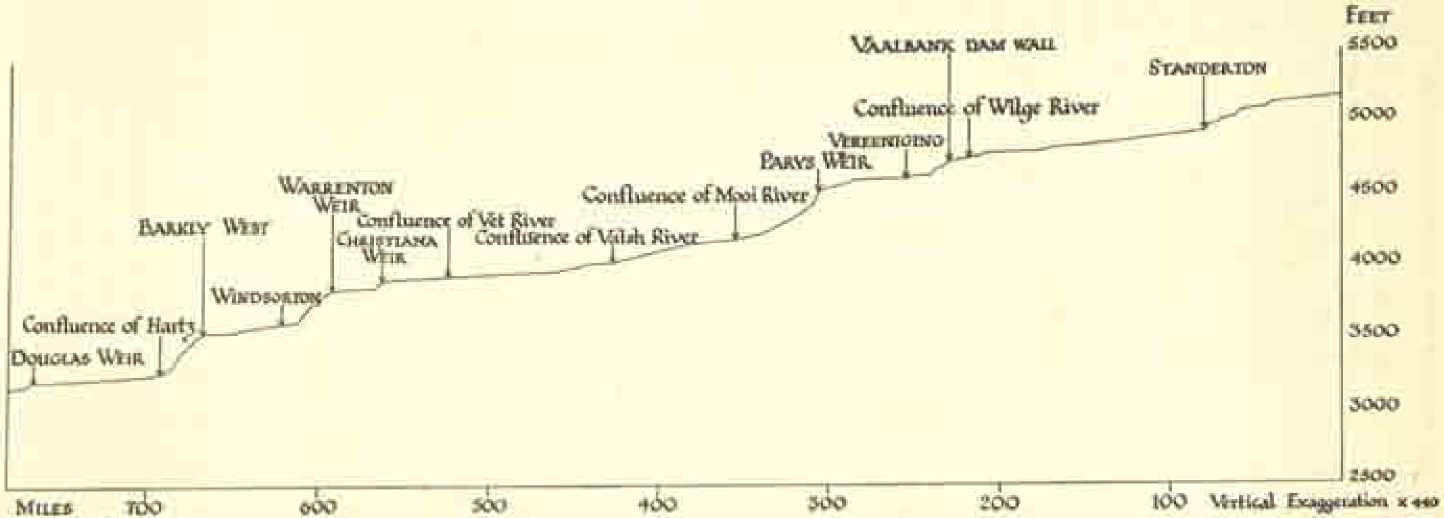


Fig. 48. Thalweg of the Vaal river from Beginderlyn road bridge to the confluence with the Orange river.

Fig. 49. The geology of the Vaal and Hartz river valleys.

Barkly West, and Douglas, they act as local base levels above which vertical erosion is retarded. Between them the river has a gentle gradient and occupies a wide valley; over them its gradient is steeper and the valley confined (Fig. 48). Below Barkly West the Vaal receives a small tributary – the Hartz. At Taungs the Hartz has a mean annual discharge of only 40,000 acre feet, less than one-tenth that of the main river, but it flows entirely over Karoo rocks and has eroded a broader and deeper valley than the Vaal, from which it is separated by a watershed of low hilly country (see Fig. 49). This relationship provides unique opportunities for the diversion of water from the main river, along which there are not any large areas suitable for irrigation farming, into the tributary valley where there are. These opportunities were recognized by the early surveyors and, in 1880, the Cape Government envisaged an irrigation scheme; but it was not until 1934 when additional water supplies were urgently needed for the expansion of the gold mining industry on the Witwatersrand (see ch. 20) and for domestic consumption in the Rand towns (see p. 150) that work began on a dual purpose project. This comprises a storage reservoir, Vaalbank dam (Plate 31), located where the river encounters resistant rock, 14 miles below the confluence of the Wilge, and a diversion weir near Warrenton, 360 miles downstream, which directs water into canals to supply the irrigation settlement in the Hartz valley (Figs. 49 and 50). The dam was completed in 1938 with an initial storage capacity of 873,000 acre feet. In 1952, however, to meet the growing needs of the mines, industries and domestic consumers in the Southern Transvaal and on the Free State Goldfields, work began on raising the dam wall by 20 feet in order to increase the storage to 1,998,000 acre feet. With its completion in 1957 the Vaal river became fully harnessed.

The main canal supplying the Hartz valley settlement, with an intake capacity of 1,000 cusecs, brings about 90,000 acres of land under irrigation, one-quarter of it in Native Territory. On the European section there are some private owners, but most of the irrigable land is cultivated by settlers placed on the land by the government. Before the war over 300 plots were allotted to people in the 'Poor White' class but after 1946 ex-service men received preference. All the prospective settlers had to complete satisfactorily a probationary period after which they became lease-rent holders and eventually full owners of their plots. By 1951 more than one thousand people had been settled and practically all the land had been taken up. The individual holdings vary between 20 and 30 morgen (42 and 63 acres) being larger than on the earlier schemes. The rather infertile sandy soils, derived mainly from Kalahari sand, require heavy applications of manure and artificial fertilizers while they tend to dry out and even blow unless bound by vegetation. They are underlain by an impervious lime layer which has created problems of waterlogging and necessitated the provision of a system of drains (Fig. 50). Under wise management, lucerne (Plate 35), groundnuts, potatoes, peas, and winter wheat are successfully grown. The wheat may be damaged by late frosts in some seasons; potatoes and tobacco suffer from

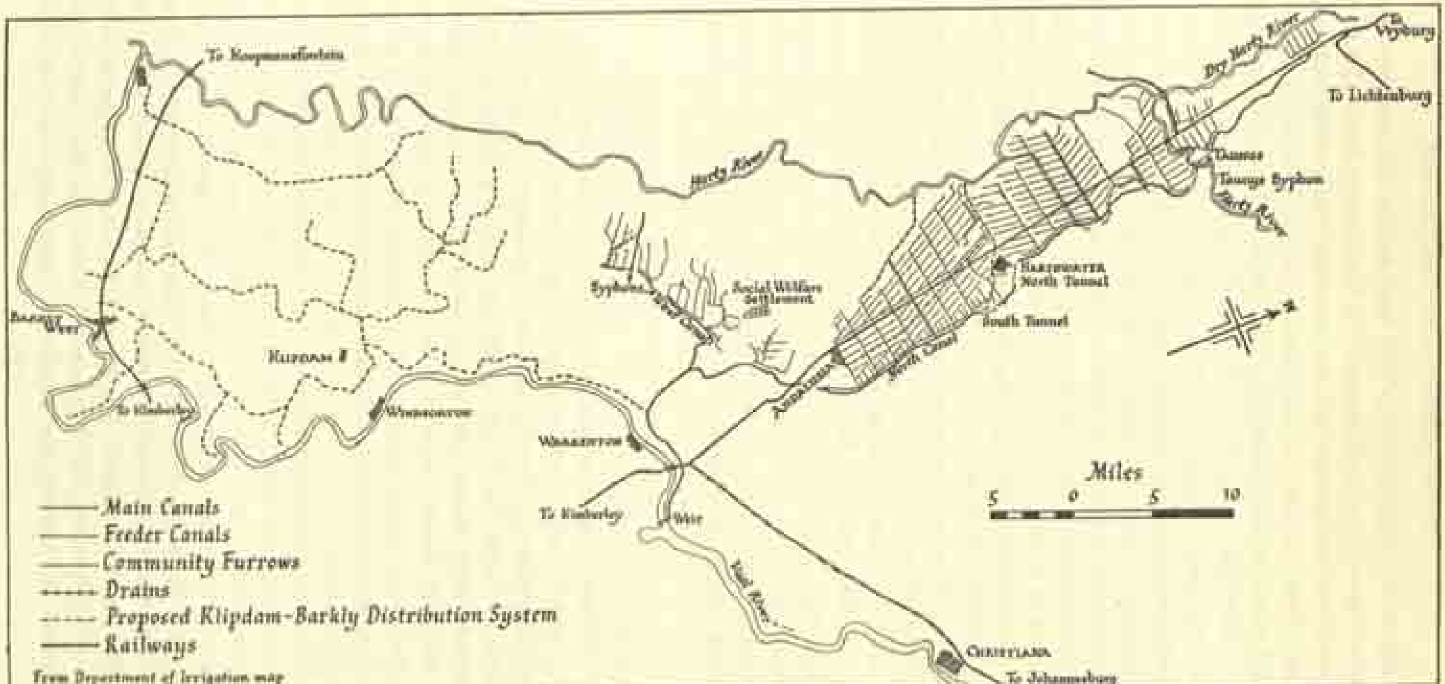


Fig. 50. The Vaal-Hartz irrigation scheme.
(After Department of Irrigation map.)

eelworm attack. To combat this careful crop rotation is essential. Dairying is carried on and some fruits are produced. In the Taungs Native Reserve, where 4-acre plots have been allotted to each headman, maize, kaffir corn and beans are the chief crops.

In 1946 work began on canals to carry water to about 150 ranches covering about 700 square miles in the Barkly West and Winsorton districts and so enable each farmer to irrigate about 40 acres for supplementary stock feed [12]. Owing to the difficult nature of the terrain, however, progress has been slow.

Until recently water had been plentiful on the Vaal-Hartz settlement but with the abstraction of increasing quantities of water for domestic and industrial purposes upstream the farmers can now rely only on their stipulated allowance. This was raised in 1950 from 24 to 30 inches [13], which is adequate for most field crops but limits horticulture and dairying based on irrigated pastures. The water shortage is unlikely to be relieved by the increased storage at Vaaldam, most of which will be required by mining, industries and domestic consumers.

Apart from about 2,000 acres at Douglas and 1,000 acres at Parys, no other lands are irrigated from the Vaal river. Near Potchefstroom, its right-bank tributaries, the Mooi river and Schoonspruit, which are fed from springs issuing from the Dolomite, however, provide water for the irrigation of nearly 20,000 acres on which wheat, lucerne, and vegetables for the Witwatersrand market are grown. A small left-bank tributary, the Rhenoster, irrigates some 2,000 acres near Kopjes, where lucerne is grown to support an important dairying industry (see ch. 13).

At present the largest dam on a tributary of the Vaal is the Kalkfontein dam, constructed where the Riet river enters a gorge some 15 miles above Koffiefontein. With a storage capacity of 298,000 acre feet this is second only to Vaaldam in size but at present only 11,500 acres are irrigated from it. The dam is situated in semi-arid sheep farming country and was built to enable each sheep farmer to irrigate about 100 acres for fodder crops for fattening lambs and for use in drought periods. Only 10,000 acres were needed for this purpose, however, and in order to utilize the surplus water plots were allocated to ex-servicemen after the war. At present these people work about 1,500 acres on which they grow wheat, potatoes and groundnuts, but it is planned to bring a further 10,000 acres under cultivation for settlers.

Potentially of far greater importance is an ambitious project in the eastern Free State, involving the construction of storage dams at Allemanskraal on the Sand river and Erfenis on the Vet river capable of storing over 210,000 and 145,000 acre feet of water respectively. These dams would provide water for irrigating 13,000 morgen (27,500 acres) of land for fodder crops for the stock farms of the Free State. Given sufficient water, however, 70,000 morgen (148,000 acres) of land could be irrigated along these two rivers. To augment the flow of these two rivers, therefore, the diversion of water from the Caledon river by means of tunnels at Ficksburg and Maseru has been suggested. Such a scheme

would also provide water for urban use on the rapidly growing Orange Free State Goldfield. Excavations for the two dams actually began in 1946, but disputes arose over mineral rights in 1948, and further work was held up until 1955. The diversion of water from the Caledon will of course require international agreement between the Union and Basutoland.

The Bushveld and Bankeveld. The Headstreams of the Limpopo River

The headstreams of the Limpopo river rising in the moderate summer rainfall area of the southern Transvaal carry relatively small volumes of water. A combination of favourable geomorphological and climatic conditions has, however, led to the construction of a number of small storage reservoirs along their valleys. Initiated on a surface of Karoo sediments (see ch. 1, p. 15 and ch. 42, p. 640) these north-flowing streams are today superimposed on the pre-Karoo rocks of the Bankeveld and the Bushveld basin.[14, 15, 16] They trench the west–east trending

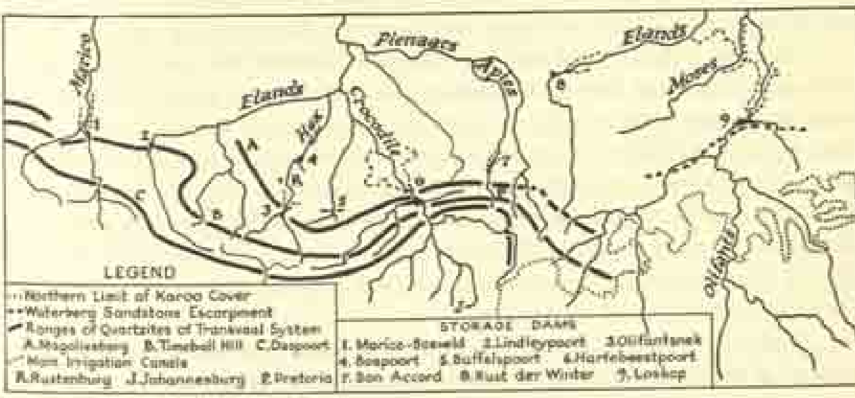


Fig. 51. Irrigation schemes in the southern Bankeveld and Bushveld.

ridges of the former in a series of poorts which provide sites for storage reservoirs and then open out into the level country of the Bushveld where, provided irrigation water is available, the climatic conditions (see ch. 42, p. 647) are favourable for a variety of sub-tropical and temperate crops, the latter grown during winter. West of Pretoria nearly every poort carries a reservoir (Fig. 51), the largest being the Hartebeestpoort dam (Plate 132).

North-east of Pretoria the Olifants river has been dammed at Loskop where, after skirting the northern edge of the Waterberg sandstone plateau for about five miles, it turns northwards and trenches the high ground formed by Rooiberg felsites and pyroclasts. Its impounded waters form a lake contained in the vale, underlain by shales of Loskop age, between the two upland areas (Plate 32). Bon Accord dam has been built where the Aapies river flows between norite kopjes and the Rust-der-Winter dam where the Elands river encounters felsite hills.

Hartebeestpoort dam[17] was the first of the large Government projects,

Loskop dam[18] is the latest. Both command a similar irrigable area (Table 1), but whereas there are 1,400 settlers on the Hartebeest scheme, when all the plots are taken up, there will only be 500 settlers on the Loskop scheme.[19] The larger plots on the latter scheme – averaging between 20 and 30 morgen (42 and 63 acres) as compared with between 8½ and 14 morgen (18 and 30 acres) on the Hartebeestpoort scheme – are due to the recognition that the holdings on the earlier schemes were too small to provide a decent living. On both schemes tobacco and winter wheat (Plate 36) are the main crops, the former harvested in March, the latter in October or November. Sunnhemp is grown in rotation between the tobacco and wheat in order to build up the nitrogen content of the soil. Potatoes are grown on the lighter sandy soils. Recently proximity to the urban market of Pretoria has stimulated the production of vegetables and flowers and the development of dairying based on lucerne on the Hartebeestpoort scheme while some enterprising farmers on the Loskop settlement have successfully ventured into the production of table grapes which come on the market before those of the Cape are ready and therefore command high prices.

Tobacco, winter wheat and vegetables are likewise the main crops on the Rust-der-Winter and Bon Accord settlements, where 5,000 acres and 1,820 acres respectively are irrigated; but west of Hartebeestpoort, where the more continuous quartzite ridges effectively exclude cold southerly airstreams in winter, citrus fruit production is the main concern (Plate 48) and the several dams were constructed to provide farmers already engaged in this enterprise with more reliable water supplies. Here over 12,000 acres are irrigated from the Hex, Elands and Sterkstroom headstreams of the Crocodile and nearly 8,000 acres from the headstreams of the Marico.

Generally speaking from an irrigation standpoint, the schemes on the headstreams of the Crocodile river have been successful. Since the waters derive from quartzite rocks, they are pure and relatively silt free. Except during the severe drought of 1932–3 when the storage at the Hartebeestpoort dam fell so low – to only 12,560 acre feet[20] – that 25,000 acres had to be fallowed in winter, there has usually been sufficient water for all the irrigable area.

In the northern part of the Bushveld basin three small dams built by the Zebediela estates where the headstreams of the Zebediela river are confined in poorts in the Chunies mountains, provide for the irrigation of 5,700 acres of citrus groves along the Gompies river, while in the Eastern Bankeveld canals led from the perennial rivers bring 8,500 acres of land under irrigation in the Ohrigstad valley, about 5,000 acres in the Steelpoort valley and 2,750 acres in the Spekboom valley, tobacco and winter wheat being the main crops grown.

The Lowveld

Although the Lowveld resembles the Bushveld in some ways, the opportunities for irrigation are very different. It is crossed by a number of trunk rivers which carry large volumes of water throughout the year, but sites for storage reservoirs

Table 1. Data Regarding Some of the More Important Storage Dams in the Union of South Africa

	Date of Construction	Length of Dam Wall (feet)	Height of Dam Wall (feet)	Initial Storage Capacity (acre feet)	Irrigable Area (acres)	Cost of Construction
A. *Orange River*						£
Buchuberg Dam	1929–34			29,900	9,950	663,293
B. *Vaal River and its Tributaries*						
1. Vaal River Development Scheme	1933–50					
(1) Vaalbank Dam	1935–8	1700	135	873,000		6,179,617
	1952–7			1,998,000		
(2) Vaal Hartz Irrigation Scheme, Warrenton Diversion Weir	1935–51			53,000	90,000	
2. Riet River. Kalkfontein Dam	1935–40	1040	113	298,000	23,300	1,608,997
3. Kaffir River. Bloemfontein				31,100	4,850	90,000
4. Sand – Vet Scheme	1946–					
(1) Allemanskraal Dam				145,600		
(2) Erfenis Dam				210,000		
C. *Bushveld Basin*						
1. Groot Marico River. Marico-Bosveld Dam	1930–5			24,400	570	285,284
2. Crocodile River. Hartebeestpoort Dam	1918–25	460	161	123,300	38,098	1,300,959
3. Bronkhorstspruit Dam	1947–51			45,400		181,699
4. Olifants River, Loskop Dam	1934–8	1420	120	156,000	38,000	2,375,091
D. *The Lowveld*						
Njelele Dam	1946–51			26,100		145,552
E. *The Cape Marginal Belt*						
1. Great Fish River						
(1) Grassridge Dam	1920–4	1530	80	63,300	44,800	171,000
(2) Lake Arthur	1920–4	1640	107	58,000	25,500	613,801
2. Sundays River						
(1) Van Ryneveld's Pass Dam	1921–5	1160	106	64,000	20,000	415,500
(2) Lake Mentz						
(*a*) Original Dam	1918–22	1260	94	94,000	23,400	564,200
(*b*) Enlargement	1948–			200,000		450,000
3. Kamanassie Dam	1919–24	1265	115	31,100	26,800	726,000
4. Breede River Brandvlei Dam						
(1) Original Dam	1920–2	3197	23	38,100	19,000	83,713
(2) Enlargement	1948–51	3252	28·5	75,000		150,000
5. Berg River Storage, Voelvlei, Tulbagh	1947–51			30,600		375,277
6. Olifants River. Clanwilliam Dam	1932–5			59,000	20,000	249,798

are generally lacking.[21] As in the Bushveld the rivers appear to have become superimposed from a Karoo cover on to the older rocks below, but the surface features of the Lowveld have been fashioned mainly by the processes of scarp recession and the western limit of the region is the Great Escarpment, over which most of the rivers tumble in high waterfalls. The Olifants river poort excepted,

Fig. 52. Principal storage dams and weirs and irrigated areas in the Union of South Africa.

1. Buchuberg. 2. Vaaldam. 3. Rand Water Board storage. 4. Vaal-Hartz weir. 5. Kalkfontein. 6. Hartebeestpoort. 7. Marico-Bosveld. 8. Olifantsnek. 9. Loskop. 10. Rust-der-Winter. 11. Longmere. 12. N'jelele. 13. Grassridge. 14. Lake Arthur. 15. Van Ryneveld's Pass. 16. Lake Mentz. 17. Kamanassie. 18. Brandvlei. 19. Clanwilliam. (From Department of Irrigation map.)

gorges like those of the Bankeveld are absent. In the Lowveld itself, where most of the surface is underlain by the Old Granite, the rivers have cut through the more resistant rocks – intrusive dykes, masses of tougher granite – in narrow defiles, but under the prevailing climatic conditions, the rocks are so deeply weathered that firm foundations for dam walls are generally lacking. Although the area was malarial the favourable temperatures, perennial rivers, and good rail facilities

encouraged the production under irrigation of sub-tropical fruits and out-of-season vegetables in the valleys of the Letaba and Crocodile rivers before the second world war. A small dam storing 2,929 acre feet of water was completed on the White river in 1939. After the war, with malaria effectively controlled, the opportunities for agricultural development and closer settlement prompted the Government to look for further dam sites. Already small dams have been constructed across the Njelele and Levubu rivers, while the feasibility of diverting water from the perennial Broederstroom and Blyde rivers, which occupy narrow valleys in the eastern Bankeveld into the broad fertile valleys of the intermittent Koedoes and Klaserie streams in the Lowveld is being investigated. Most of the cultivated land in the Transvaal Lowveld, however, is irrigated from canals led directly from the tributary streams or fed by water pumped from the main rivers by the individual land owners.

The first Government scheme in the Lowveld was much farther south along the Pongola river, where a diversion weir and system of unlined canals, bringing about 12,000 acres under irrigation, was built between 1932 and 1935. Plots were allocated to a number of settlers but owing to the poor rail facilities and the general inaccessibility, little success was achieved. In 1941, the Government closed the scheme to further settlement and took over the unoccupied land for the production of vegetables required for military forces. After the war experiments with sugar cane proved successful, but the area being more than 100 miles from the nearest sugar mill in the Natal cane belt, commercial production hinged on the provision of a local mill. As this required, for economic operation, more cane than the existing irrigable area could supply, the capacity of the main canal has been increased from 190 cusecs to 350 cusecs and the canal system extended to bring additional land under irrigation. At present a further scheme involving the construction of a dam where the Pongola cuts through the Lebombo range in a narrow poort is being investigated; this would bring a further 170,000 acres of land in the coastal plain between the Pongola and Mkusi rivers under irrigation[11].

Between the Pongola and the Crocodile rivers irrigation is at present limited to small diversion schemes on the Komati near Balegane and on the Usutu near Stegi in Swaziland and along the Letubi and Lomati valleys in the Union (see Fig. 52).

The Cape Marginal Belt

Irrigation developments in this territory afford many contrasts with those in the areas already considered.

The practice of irrigation in South Africa began in the valleys of the south-western Cape where later schemes, both private and governmental, have been undertaken largely to meet the needs of expanding and prosperous agriculture. By contrast, in the southern and south-eastern Cape, some of the first Government projects were undertaken to enable ostrich farmers, distressed by the

collapse of the feather market, to take up fruit and tobacco production for which perennial irrigation was essential. Accordingly between 1918 and 1925 Lake Mentz and Van Ryneveld's Pass dam were constructed across the Sundays river, Lake Arthur and Grassridge dam on the Brak and Tarka tributaries respectively of the Great Fish river and Kamanassie dam on the river of the same name.

These contrasts are in part a reflection of the differing opportunities for irrigation and farming occasioned by differences of climate and of structure and relief between the south-western, southern and south-eastern Cape.

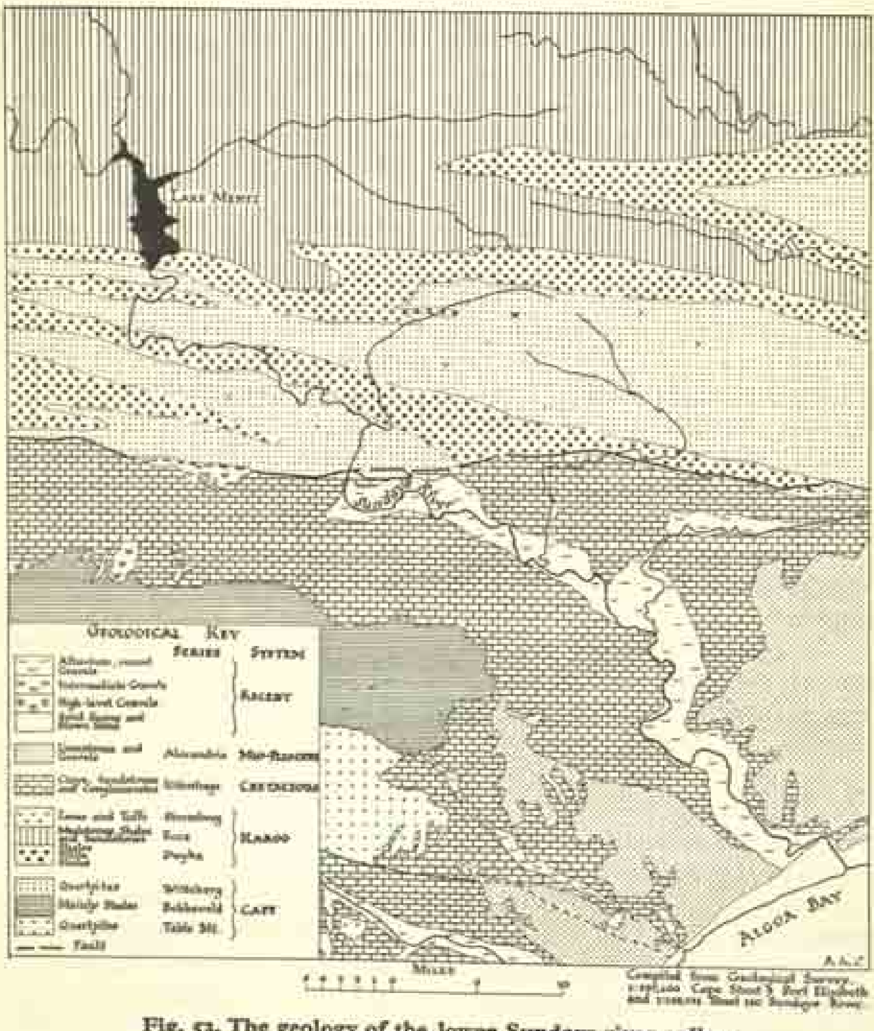


Fig. 53. The geology of the lower Sundays river valley.

The south-eastern Cape – the Great Fish and Sundays Rivers

Here the two major rivers – the Great Fish and the Sundays – rise along the Great Escarpment and traverse considerable stretches of the arid Great Karoo before crossing the ranges of the Cape Folded Belt to reach the sea. The greater part of the catchment area of both rivers is underlain by shales and sandstones of Karoo age and by intrusive dolerite.

The Great Fish river has three main headstreams – the Great Fish, Great Brak and Tarka which rise respectively in the Sneeuwbergen, Zuurberg and Winterberg and unite near Cradock. Below Middelburg the main river turns

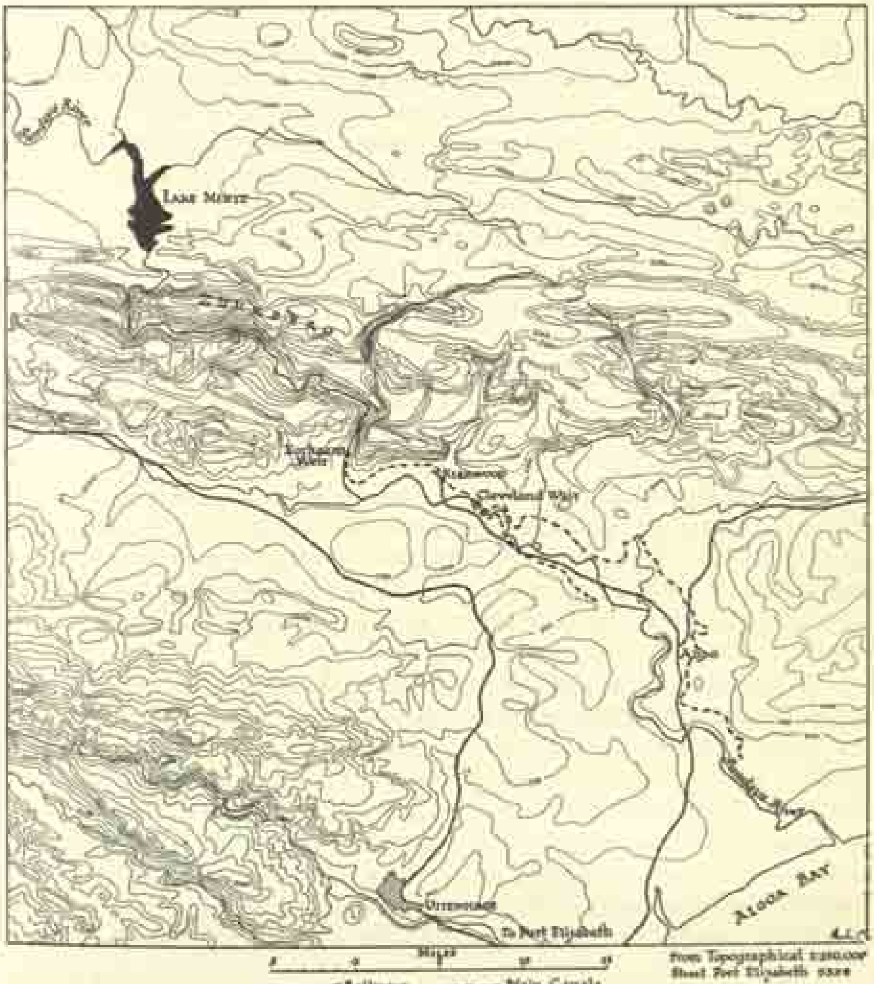


Fig. 54. The relief of the lower Sundays river valley and the Lake Mentz irrigation scheme.

eastwards and crosses the Cape ranges at their eastern extremity where they reach the sea. There are extensive stretches of rich alluvial soil along the Great Fish river and its tributaries but their utilization is restricted by the limited opportunities for irrigation. There are few good dam sites. The two which have been utilized occur where the Great Brak and Tarka rivers pass between dolerite kopjes. Even here difficulties were experienced in finding suitable foundations while a dam wall exceeding 1,800 feet in length at the crest was necessary to close the gap on the Tarka river – to effect a storage of only 58,000 acre feet.

The Sundays river rises in the Koudeveldberg. In the Great Karoo its valley is relatively open but above Graaff Reinet the river has cut a poort through dolerite kopjes. Southwards the river crosses the Cape Folded Belt where it is characterized by well-defined west–east trending ranges and valleys. Here the river is superimposed on the Cape rocks and has cut deep and narrow transverse poorts through the exhumed ranges. Farther south the valley widens where the river crosses the plain of Cretaceous and Tertiary sediments to the sea. Between the relief barriers and again on the coastal plain, there are extensive stretches of alluvium. These provide the irrigable areas while the poorts afford dam sites – Van Ryneveld's Pass dam being constructed where the dolerite is crossed and Lake Mentz in the Witteberg range* (Figs. 53 and 54).

Although these dams were provided with sluice gates for scouring purposes siltation has been serious. The capacity of Van Ryneveld's Pass dam was reduced from 64,000 acre feet at its completion in 1924 to under 51,000 acre feet in 1946; that of Lake Mentz decreased from 94,000 acre feet in 1922 to below 62,000 acre feet in 1935; in the following year the gates were raised to increase the capacity to over 87,000 acre feet, but this has been reduced to less than 60,000 acre feet. The dam wall is being raised again to increase the storage to 200,000 acre feet, but it is anticipated that at the present rate of siltation this will have decreased to 135,000 acre feet by 1970. At present the Van Ryneveld's Pass scheme commands 35,000 aces of land, of which 22,300 acres is irrigable but the water supply is sufficient only for 8,200 acres. The Lake Mentz canal system commands nearly 40,000 acres, but only 23,000 acres can be irrigated.

At one time serious alkali troubles were experienced in the Sundays river valley. Fundamentally these were due to the high alkali content of the water – (for the Karoo shales and dolerites of the catchment area are impregnated with alkalis) – which became concentrated when the water was stored under hot arid conditions. They arose when the water was diverted both at Korhaansdrift some 28 miles below Lake Mentz and at Cleveland 41 miles farther downstream; between the two weirs a seepage stream flowed in so that the water diverted at Cleveland weir was brackish. With changes in the canal system and the diversion of sufficient water at Korhaansdrift to supply the needs of all farmers the difficul-

* The wall is actually built into Dwyka conglomerate which provides sound foundations; the quartzites are severely folded, the dips are nearly vertical and the rocks are badly shattered.

34. Pump for raising water from the Pienaars river in the Transvaal Bushveld Basin in order to irrigate wheat and tobacco lands. Except on the irrigation schemes this is the usual method of obtaining water for irrigation in the Bushveld. The photograph was taken in winter when the river carried very little water, the whitish patches being in fact stretches of sand in the river bed.

35. Cutting lucerne on the Vaal-Hartz irrigation scheme. In the background settlers' homesteads.

36. Wheat harvest on the Loskop irrigation scheme. In the background is the scrub savanna of the Bushveld.

37. Sugar cane covering the hills between Gingindlovu and Eshowe. The contourwise clean breaks are to reduce the hazards of fire.

38. The light railway for conveying cane from the fields to the sugar mill.

39. The sugar cane harvest, Natal coastal belt. The cane is cut by hand by African male labour. Today few Indians are employed in the cane fields.

Fig. 55. The scheme for the diversion of water from the Orange river into the Great Fish and Sundays river valleys.

1. Orange river storage. 2. Doornpoort barrage. 3. Tunnel to Theebus spruit. 4a. Brak-Conway-Fish river canal. 4b. Theebus-Hofmeyr canal. 5. Van Ryneveld's Pass tunnel. 6. Great Fish-Little Fish canal. 7. Little Fish-Bushman's river canal. 8. Schoenmakers spruit channel to Lake Mentz.

ties were largely overcome but care in the application of irrigation water and adequate drainage are essential.

Despite these difficulties favourable climatic conditions, fertile soils and proximity to Port Elizabeth have enabled the Sundays river valley to become one of the leading fruit producing and exporting areas in the Union. The existence of further large areas suitable for this purpose both in the Sundays and in the Great Fish river valleys has directed attention to the possibility of diverting water from the Orange river into these valleys. It is estimated that not more than 10 per cent of the Orange river water will be required for irrigating land within its own valley, while investigations suggest that Orange water could be diverted into the headwaters of the Fish river by a tunnel about 50 miles long under the Kikvorschberg. The scheme[23] (Fig. 55) envisages a diversion barrage on the Orange at Doornpoort near Venterstad which would direct water into a 3,300 cusecs canal leading to the tunnel. Before entering the tunnel the water would pass through desilting works. On emerging from it some of the water would be led off to irrigate land near Conway, while the remainder would pass down the Fish river to Grassridge dam which would be raised to receive the extra water. Thence some water would be let down the river to supply existing schemes while the rest would be conveyed via the Little Fish river and canals to Lake Mentz and to the Bushmans river. This scheme would increase the area under irrigation in the two main valleys to 275,000 morgen (nearly 800,000 acres), but the cost is estimated at £70 million.

The southern Cape

The southern Cape is characterized by parallel west–east-trending ranges and valleys. The main streams rise either in the Cape mountains or along the Great Escarpment, cut narrow poorts through the ranges and occupy broad longitudinal valleys between them. Here there are good spreads of fertile alluvial soil but the opportunities for perennial irrigation are very limited. The mountains receive 40 to 70 inches of rainfall but the vegetation, impoverished by repeated veld burning, is incapable of holding the moisture, the run-off is rapid and many of the streams are intermittent. The only important irrigation scheme is on the Kamanassie river which rises in a subsidiary range between the Swartberg and the Outeniqua mountains. The river has an annual discharge of over 1,000 million cubic feet and since it drains an area built of Table Mountain Sandstone and Bokkeveld shale it is relatively free from silt. A suitable dam site was found where the river passes from the Bokkeveld shales on to the overlying Enon (Cretaceous) conglomerates[24]. The dam had an initial capacity of about 31,000 acre feet; the canal system commands nearly 27,000 acres of land. The water is taken out at two levels in order to supply the valley bottom lands and also the old river terraces. Tobacco and lucerne are the chief crops while small acreages are devoted to vineyards.

The south-western Cape

Here the juxtaposition of high mountains and broad valleys and basins provides exceptional opportunities for irrigation.

Perennial rivers rising on mountains, which are built of Table Mountain Sandstone and drenched in copious winter rains, carry large quantities of clear silt-free waters into the major basins; around the margins of these basins numerous small streams issue from springs thrown out where the Table Mountain Sandstone comes in contact with less permeable shale of the Bokkeveld or Malmesbury Series. Water is thus plentiful on most farms within the basins where it is stored in innumerable small private dams (Plate 33) and used to irrigate orchards and vineyards.

Water problems, however, are experienced along the Breede and Olifants valleys where the climate is more arid. Here the need for storage schemes has arisen. At first small schemes embracing less than twenty farms were carried out with the aid of Government loans. More recently comprehensive projects have been undertaken.

The most important works in the Breede valley is the Brand Vlei dam. The Brand Vlei was originally a natural pan fed by hot springs and the backwater of periodical floods of the Breede river. Between 1920 and 1922 it was converted into a reservoir capable of storing 38,000 acre feet of water by the construction of an earthen embankment over 3,000 feet long. To augment the inflow of water from the local catchment area a feeder canal was built from the Holsloot river. The purpose of the dam was to replenish the flow of the Breede river during periods of low flow and so provide perennial water for the irrigation works downstream. As the dam, however, cannot provide water for all the irrigable land in the valley, sites for new reservoirs are now being sought in the mountains. Here a site in Mitchells Pass below the confluence of the Breede and Wit rivers appears promising.[25]

The largest irrigation dam in the south-western Cape is on the Olifants river near Clanwilliam where the climate approaches that of the hot desert. Completed in 1935 with a storage capacity of 59,000 acre feet, the dam was built to extend an earlier irrigation scheme served by the Bulshoek barrage which, with a storage of only 5,300 acre feet, proved inadequate to meet the needs of the area commanded by the canal system.[26] Clanwilliam dam is located in mountainous country at the point where the Olifants river passes from the Table Mountain Sandstone on to the Bokkeveld Shale. The irrigated area, which totals 20,000 acres, extends over the Bokkeveld and Malmesbury formations. Several difficulties have been experienced on this scheme. Originally the canals were unlined but the loss of water by leakage where the canals had to be carried over the porous Table Mountain Sandstone was so great that lining at great cost became necessary. More serious, maintenance costs are high for erosion occurs on the steep slopes over which the canals have to be carried, and the canals have frequently to be

cleared of the sand blown into them by strong winds emanating from the coast and the arid interior[27]. With the production of citrus fruits, raisins, barley and lucerne, however, the agriculture is more profitable than on some schemes in other parts of the country.

The Marginal Lands of Natal and the Transkei

Although the rivers of the eastern marginal belt carry large volumes of water throughout the year opportunities for irrigation are very limited, sites suitable for large storage reservoirs being generally absent and irrigable land scarce. A number of small storage schemes have been constructed in Native territory along the Tugela river while around Muden in the Mooi valley European farmers have grown citrus fruits under irrigation for many years.

At present sites for small reservoirs to serve industrial and domestic needs are being sought in the valleys of the Tugela and Buffalo rivers; and it seems likely that in view of the varied resources and great industrial potential of this region water conservation will be directed to meet industrial rather than agricultural needs.

The Provision of Water for Urban and Industrial Uses

Judged in the light of the general scarcity of water over the greater part of South Africa, the major towns have been comparatively fortunate in obtaining reliable supplies of water, although this has involved the building of storage reservoirs at some distance from their centres to meet the needs of their increasing population. In many cases this happy position is due to the care taken in the original siting of the town.

Good supplies of water played an important part in the selection of Bloemfontein, Pietermaritzburg, Potchefstroom and Pretoria as the capitals of the old Voortrekker republics during the nineteenth century. Thus Bloemfontein, as its name suggests, was founded at the site of a perennial spring. Pietermaritzburg was founded at the foot of the Bushmans Rand at a point where copious supplies of water ran down from the neighbouring hills; its first water supply was readily obtained from a furrow dug from the Dorp spruit.[28] This sufficed until 1900 when water was first brought by pipeline from the Umzimdusi river, nine miles away. Since then the growing needs of the town have been met by building storage reservoirs on this river and laying additional pipelines so that today the town has an assured daily supply of 12½ million gallons of water. Both Potchefstroom and Pretoria were founded where strong springs issue from the Dolomite. Potchefstroom still depends on this source but Pretoria has outgrown the supplies from the springs in the Fountains valley, south of the town, and the Sterkfontein spring at Olifantsfontein and now obtains additional water from a dam across the Six Mile Spruit at Rietvlei and from Vaaldam through the Rand Water Board.[29]

In contrast to the old Voortrekker capitals, the major ports and the Wit-

watersrand towns have for many years had to bring their water supplies from a distance.

Cape Town's first piped water supply came from small storage reservoirs on the slopes of Table Mountain.[30] This source sufficed until 1921 when the town had to go 40 miles away to the Hottentot Holland mountains where a dam was built across the Steenbras river. Enlarged in 1927 this stores nearly 6,000 million gallons. With the greatly increased water consumption due to the growth of industries and population after 1939 this became inadequate and in 1952 work began on a large new dam in the Wemmershoek valley 40 miles north-east of Cape Town. This was completed in 1957.

East London likewise has had to go about 40 miles for its water, the main supply now coming from the Laing dam on the Buffalo river.[31] This impounds nearly 5,500 million gallons to give a daily supply of 11 million gallons, five times the present consumption of the town. Port Elizabeth has had to go even farther for its water supply, which comes mainly from the Churchill dam on the Kromme river some 80 miles from the city centre.[32] The storage effected by this dam is sufficient for a daily supply of 20 million gallons even if the catchment area experiences three years' drought. The present pipelines provide for a daily consumption of 13 million gallons but when the new pipelines are completed, by 1960, 20 million gallons will be available.

Durban, too, has had to go progressively farther afield for its water.[33] The town first relied on local wells but in 1887 it became necessary to bring water from the Umbilo river at Pinetown. Four years later these sources had to be supplemented by supplies from the Umlaas river at Camperdown. As the town grew, however, it became necessary to go farther afield for water and build storage reservoirs first on the Umlaas river where the Camperdown dam was completed in 1902 and the Shongweni dam in 1927 and later on the Umgeni river where the Nagle dam was completed in 1950. Following storm damage in 1943 the Camperdown reservoir was abandoned. Today Durban's main water supply comes by pipeline from the Shongweni and Nagle reservoirs, the pipelines from the latter reservoir being carried in tunnels and aqueducts across the difficult dissected country of the Valley of a Thousand Hills (Fig. 56) (Plate 101). The present Umgeni scheme will eventually provide 50 million gallons of water daily. The present average daily consumption in Durban is half this amount but a peak of 33 million gallons has been experienced.

The provision of water for the mines and towns of the Witwatersrand[34] has been a major problem ever since the discovery of gold in 1886. The Witwatersrand is a major watershed and the streams flowing from it carry only small quantities of water. Although the Jukskei river was used for crushing the ore in the early days and limited supplies of domestic water were obtained from boreholes in the Witwatersrand and Ventersdorp rocks, the development of the goldfields has depended from the beginning on water supplies from without the region. Fortunately good supplies of water, sufficient to sustain the early

development of gold-mining, were found in the Dolomite south of Johannesburg. The first supply came from Zuurbekom, some 17 miles south-west of the city. Here subsurface dykes seal off a Dolomite basin which yielded an initial daily supply of 2½ million gallons of remarkably pure water. This was later increased to 7 million gallons. In 1911 it was augmented from a series of boreholes in the Dolomite in the Klip river valley at Zwartkopjes, about 12 miles south of Johannesburg. At first these boreholes yielded about 6 million gallons per day but with continued pumping the yield fell to only 2 million gallons in 1914. At the same time the hardness of the water increased. Meanwhile the recognition of the vital

Fig. 56. The water supply of the city of Durban.
(After city and water engineer.)

importance of an adequate water supply to the development of the region had led, in 1903, to the formation of the Rand Water Board composed of representatives of six municipalities and the Chamber of Mines. Subsequently four other municipalities and the Railway Administration joined the Board. By 1911 it was clear that the Dolomite could not provide all needs and that water would have to be brought from the Vaal river. The enormous seasonal fluctuations in the volume of this river (Fig. 45), however, made some measure of control over its flow essential. Accordingly a barrage was built some 23 miles below Vereeniging. Completed in 1923 it effected a storage of 12,500 million gallons of water, giving an assured daily supply of 20 million gallons. By 1934, however, this became inadequate for the growing needs of the Witwatersrand. The Government was then considering the construction of a dam either above Vereeniging or at Fourteen Streams to provide water for the irrigation of the Hartz Valley (see p. 134). When, however,

the Rand Water Board offered to contribute £240,000 towards the construction of a storage dam above Vereeniging in return for the right to abstract 60 million gallons of water daily, the Government decided to build the Vaaldam just below the confluence of the Vaal and Wilge rivers, as part of a dual-purpose project (see p. 134).

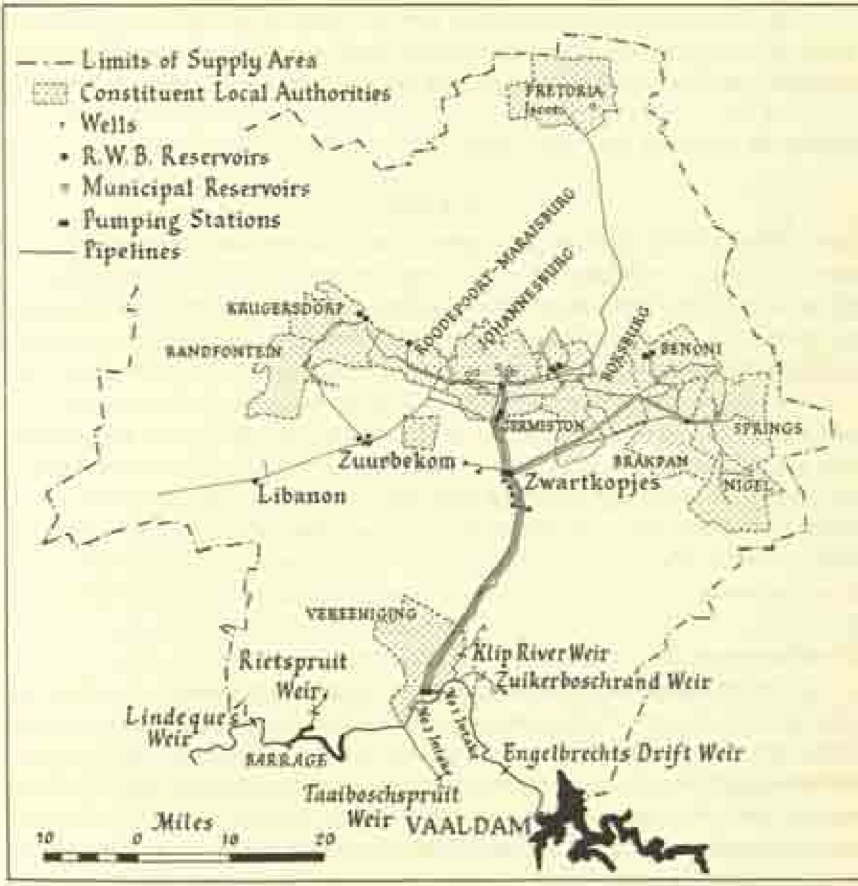


Fig. 57. The Rand Water Board supply area.
(After J. P. Leslie.)

After the second world war, however, the greatly increased demands on the Vaal river water, caused by the development of the Orange Free State goldfields, the oil-from-coal project near Vereeniging, new electricity generating stations and the growth of industries, necessitated increasing the storage capacity of Vaaldam to nearly 2 million acre feet giving a daily supply of 630 million gallons of water. Even this, however, threatens to be inadequate to meet all demands by

the turn of the century when it is anticipated that the municipalities, the mines, electricity undertakings and industries, as well as agriculture, will require a net supply of 935 million gallons per day. To meet the shortfall a series of barrages below Vereeniging are envisaged while the diversion of water from the Caledon river (see p. 136), as part of a multi-purpose project providing for domestic, irrigational and industrial needs, is being considered.

The only other important project benefiting domestic and industrial consumers is near Gouda in the south-western Cape, where the waters of the Klein Berg river are diverted into a natural pan, the Voelvlei, whence they are let down the Great Berg Valley to supply the establishments connected with the fishing industry in Saldanha Bay. This project was completed in 1952.

The Future

Since 1930 the South African Government has been spending increasing sums of money on large schemes for the conservation of water for agricultural, domestic and industrial purposes. More than ½ million acres of land have been brought into productive agricultural use, mining and manufacturing have been aided on the Witwatersrand. The best dam sites have already been utilized and the Vaal river fully harnessed. Future schemes must of necessity be more ambitious and more costly. Already schemes involving the diversion of water from the Caledon river in order to irrigate land in the Sand and Vet valleys and from the Orange river to irrigate land in the Sundays and Great Fish valleys are being considered. Before embarking on such costly projects, however, the economic status of farming on the irrigation schemes should be closely examined. At the same time the allocation of water between domestic, agricultural and industrial users should be carefully considered. Indeed, the time has come when the whole question of the utilization of the nation's water resources should be reviewed.

A disappointing feature of many of the irrigation settlements in South Africa is the high percentage of irrigable land used for cereal crops which bring in a low return per acre; when in many cases the physical conditions favour more profitable horticultural crops, for which in canned or frozen form there should be large markets overseas, as well as dairying based on irrigated pastures and fodder crops. Often lack of capital and technical resources hamper the full utilization of the land. But if further heavy expenditure on irrigation is to be justified, clearly the land must be made to yield the maximum return of which it is capable.

The allocation of the available water resources between domestic, agricultural and industrial users to secure the greatest national benefit involves the whole question of the South African Water Law. This is based on the 'riparian' principle, whereby the landowners have the right to use the stream flow past their properties in perpetuity for 'reasonable domestic purposes', i.e. for primary purposes. The restrictions imposed by acceptance of this principle virtually prohibited the development of large scale irrigation schemes before the passing of special acts for the Cape in 1906 and for the Union in 1912 (see pp. 119–120). While

safeguarding the rights of 'riparian' owners, these acts established certain rights regarding the abstraction of water for secondary uses, including irrigation. At the same time the use of water for industrial and other tertiary purposes was made subject to water being available after all the reasonable primary and secondary requirements of the riparian owners below the proposed industry had been safeguarded. This is still the position today. Its effect has been to hinder industrial development everywhere except in the towns where, due to a curious legal interpretation of the law, municipal water may be used for industrial purposes. The result has been the concentrated growth of industries in the towns and particularly on the Witwatersrand where enormous demands are made on the water resources of the Vaal river.

In order to provide water for the gold mines, for the municipalities and industrial users in the southern Transvaal it has been necessary to invoke the 'principle of appropriation', a method resorted to in the federal projects in North America and elsewhere. It was first applied on a large scale to enable the construction of Vaaldam, a special act being passed in 1934. It is likely to be used more extensively in the future. Hitherto the rivers flowing to the Indian ocean have been scarcely tapped. Their potential may be gauged from the fact that whereas the flow of the Vaal at Vaaldam is below 2 million acre feet the combined average flow of the Tugela, Umgeni, Pongola, Usutu, and Crocodile-Komati far exceeds 10 million acre feet. Opportunities for irrigation farming in the valleys of the Natal rivers are limited but opportunities for industrial development are great – provided rights to the use of water for industrial purposes can be obtained.

Today there is growing interest and concern over the control of the Union's water resources. In his report for the period 1940–6 the Director of Irrigation envisaged the nationalization of the Union's limited water resources but more recently the Report of the Commission of Enquiry concerning the Water Laws of the Union (1952) has recommended increased state control over water supplies while maintaining and safeguarding riparian rights.

BIBLIOGRAPHY

1. Annual reports of the Director of Irrigation for the Union of South Africa, Government Printer, Pretoria. Most of the information relating to Government schemes is obtained from these reports.
2. J. F. ENSLIN. 'Die beperkte ondergrondse watervoorraad van die Unie'. *Tydskrif vir Wetenskap en Kuns*, Nuwe reeks. Deel IX, Tweede aflewering, 1949, pp. 143–64.
3. Union of S.A. Bureau of Census and Statistics. Agricultural Census No. 24, 1949–50. Special Report Series, No. 23. Boreholes, Wells and Springs on the Farms. Pretoria. 1953.
4. L. T. NEL and H. F. FROMMURZE. 'The occurrence, location and exploitation

of underground water in South Africa'. *Afr. Reg. Sc. Conf.* 1949. Johannesburg. Comm. No. A (f) 3.

5. See H. F. FROMMURZE. *The water bearing properties of the more important geological formations in the Union of South Africa.* Geol. Surv. Mem., No. 34. Pretoria. 1937.
6. G. W. BOND. *A geochemical survey of the underground water supplies of the Union of South Africa.* Geol. Surv. Mem. No. 41. Pretoria. 1946.
7. D. G. STEYN and N. REINACH. 'Water poisoning in man and animals together with a discussion on urinary calculi'. *Onderstepoort J. Vet. Sc.*, Vol. XII, i, 1939, pp. 167–229.
8. See A. D. LEWIS. 'Report on a flying reconnaissance of the lower Orange river'. *Ann. Rep. Dir. Irrig. of the Union of S.A.* for the period 1st Apr. 1912–31st Mar. 1913. Pretoria. 1914.
9. See *Ann. Rep. Dir. Irrig. of Union of S.A.* for the period 1st Apr. 1918–31st Mar. 1919. Govt. Printer. Pretoria. 1920.
10. J. H. MOOLMAN. 'The Orange river, South Africa'. *G.R.*, Vol. XXXVI, No. 4, Oct. 1946.
11. See *Ann. Rep. Dir. of Irrig. of Union of S.A.* for the period 1st Apr. 1929–31st Mar. 1930. Govt. Printer. Pretoria. 1931.
12. See *Ann. Rep. Dir. Irrig. of Union of S.A.* for the period 1st Apr. 1940–31st Mar. 1946. Govt. Printer. Pretoria. 1947.
13. See *Ann. Rep. Dir. Irrig. of Union of S.A.* for the period 1st Apr. 1950–31st Mar. 1951. Govt. Printer. Pretoria. 1952.
14. J. H. WELLINGTON. 'Stages in the process of river superimposition in the southern Transvaal'. *S.A.J. Sc.*, Vol. XXXVII, 1941.
15. J. H. WELLINGTON. 'The present cycle of erosion in the Magaliesberg'. *S.A.J. Sc.*, Vol. XXIII, 1926.
16. J. H. WELLINGTON. 'The Vaal–Limpopo Watershed'. *S.A.G.J.*, Vol. XII, 1929.
17. See *Ann. Rep. Dir. Irrig. of Union of S.A.* for the period 1st Apr. 1933–31st Mar. 1934.
18. See *Ann. Rep. Dir. Irrig. of Union of S.A.* for the period 1st Apr. 1938–31st Mar. 1939.
19. See *Ann. Rep. Dir. Irrig. of Union of S.A.* for the period 1st Apr. 1948–31st Mar. 1949.
20. See *Ann. Rep. Dir. Irrig. of Union of S.A.* for the period 1st Apr. 1932–31st Mar. 1933. Govt. Printer. Pretoria. 1934.
21. See *Ann. Rep. Dir. Irrig. of Union of S.A.* for the period 1st Apr. 1917–31st Mar. 1918.
22. Information supplied by the Director of Irrigation.
23. Ditto.
24. See *Ann. Rep. Dir. Irrig. of Union of S.A.* for the period 1st Apr. 1919–31st Mar. 1920. Govt. Printer. Pretoria. 1921.

25. See M. S. TALJAARD. 'Morphological and hydrological aspects of the Tulbagh–Swellendam Mountain Foreland with special reference to the social and economic significance of surface water resources'. *S.A.G.J.*, Vol. XXXIII, 1951.
26. See *Ann. Rep. Dir. Irrig. of the Union of S.A.* for the period 1st Apr. 1932–31st Mar. 1933. Govt. Printer. Pretoria. 1934.
27. See *Ann. Rep. Dir. Irrig. of the Union of S.A.* for the period 1st Apr. 1940–31st Mar. 1946.
28. *The City of Pietermaritzburg*. Official Guide. 1952.
29. *The City of Pretoria*. Official Guide. 1951.
30. *The City of Cape Town*. Official Guide. 1954.
31. *The City of East London*. Official Guide.
32. *The City of Port Elizabeth*. Official Guide.
33. *The City of Durban*. Official Guide. 1953.
34. J. P. LESLIE. 'Water supply of the Witwatersrand'. *J. S. Afr. Inst. Engrs.*, Vol. XLIV (6), June–July, 1946, pp. 184–204.

Agriculture, Forestry, and Fishing

8

Agriculture: General Considerations

Agriculturally South Africa is a relatively poor country enjoying few advantages and suffering many disadvantages both of a physical and of an economic nature. Some of the difficulties are directly attributable to physiographic evolution and present surface form. In the first place because of its vast extent, great altitude and level surface, the plateau which makes up most of the country experiences a modified temperate climate in sub-tropical latitudes; the moderate temperatures, dry atmosphere and abundant sunshine permit out-of-door activities the year through but they are associated with great ranges of temperature, winter frost and high summer maxima, and inadequate, highly seasonal and unreliable rainfall, which are unfavourable for plant growth. Combining certain characteristics of both temperate and tropical climates the conditions are rarely at an optimum for the crops of either type. To a lesser extent these remarks are true also of the marginal lands, where the country is characteristically elevated. Because of these modified conditions the winters are seldom sufficiently cold for temperate deciduous fruits while the occurrence of frosts and the great diurnal and annual ranges of temperature limit tropical fruit production. Wheat can be grown only in winter and, except in the south-western Cape and during favourable seasons on the south-eastern Highveld, irrigation is necessary; moreover in the summer rainfall area it may be damaged by hail or rust before harvest. Maize succeeds on the Highveld but a short growing season, characterized by extremes of temperature and humidity and the occurrence of periods of drought, depresses yields. In the eastern marginal lands the climatic conditions generally favour the growing of sub-tropical crops but the areas suited to cultivation are limited in extent by reason of the hilly nature of much of the terrain, while irrigation during the dry season is essential for perennial crops. Likewise in the south-western Cape level land is restricted and irrigation necessary for perennial crops during the dry summer.

Apart from the general characteristics of the climate the amount and distribution of the rainfall is such that less than one-third of the country receives sufficient for crop production, and here most of the land is mountainous or hilly and unsuited to arable cultivation. In the drier western areas crops can be grown

only under irrigation and unfortunately opportunities for the development of schemes involving storage reservoirs and a permanent system of canals are very limited (see ch. 7). Furthermore, because of the long continued uplift of the country, the predominance of ancient rocks and the extremes of temperature and humidity, there has been little opportunity for the development of soils most of which are immature and deficient in plant nutrients. To all these disadvantages is added the fact that most of the farm operations are conducted by people lacking in the tradition and skill of agriculture.

In view of the foregoing it is not surprising that South Africa is predominantly a pastoral country. Even here, however, difficulties are experienced. In the drier parts of the country not only is the carrying capacity of the natural vegetation low, but considerable livestock losses occur in years of drought. In the hotter areas diseases are rife and necessitate regular precautionary measures, while in many parts unfavourable climatic conditions, poor feeding and inferior animals result in low milk yields and poor quality meat.

Formerly plagues of locusts caused considerable losses both to crops and pasturage in the drier parts of the country, but thanks to co-ordinated control services and constant vigilance the farmers are very largely free of such threats at the present day.

Despite the difficulties the present century has been one of great agricultural change and progress in southern Africa. Whereas the period from 1652 to the end of the nineteenth century was concerned essentially with the occupation of new lands, consolidation taking place only in the south-western and south-eastern Cape, the past half-century has witnessed the change from a subsistent to a commercial economy in the European areas. By 1900 the trekking period was over for no vast expanses of grassland remained to be colonized. Thereafter as the agricultural population increased the farms had to be divided (see Fig. 58) and the land put to more intensive use. Naturally several stages were passed through; progress in each being aided by the growth of population associated with the exploitation of mineral wealth, by the inflow of foreign capital, the growth of communications and the development of industry and hastened by the effects of two world wars.

Until the first world war the rearing of sheep for wool and of cattle for trek-oxen, and only incidentally for hides, predominated. The production of grain and of dairy produce was insufficient for home needs; fruit was grown only for local markets. Surplus wine was produced in the Cape but the export was very small. The war gave an impetus to grain production and during the 1920's maize growing expanded so rapidly on the Highveld that South Africa became an important maize exporter. The beef and dairying industries, however, labouring under difficult climatic conditions and hampered by the lack of high-grade animals, could not compete with those of more favoured countries, e.g. the Argentine, New Zealand. So the farmers grew maize year after year and kept large numbers of trek-oxen for carrying out the cultural operations. Animals were sold for

slaughter only when they were too old for work. Tractors were unknown in South Africa at this time. But as the soils in the first tilled areas became depleted and as new land in areas too dry for continuous cropping was broken by the plough so soil deterioration and erosion became serious problems whose solution was hampered by the lack of home produced artificial fertilizers, the absence of rotation crops suited to the local conditions and the difficulties in the way of a mixed economy. During the same period the growing of deciduous fruit in the south-western Cape and of citrus fruit in the south-eastern Cape and the Transvaal went ahead, and an export trade developed but the growers were troubled by various physiological troubles, low yields and marketing difficulties. And finally came the great slump when wool, maize, and fruit prices in particular fell sharply. This, however, marked the beginning of a new era in South African agriculture, for at once the Union Government undertook irrigation projects, introduced protective tariffs on some crops and established machinery for the marketing of other produce, speeded the erection of the first big iron and steel works in the country at Pretoria and encouraged the growth of industry. The provision of water permitted intensive agriculture in selected areas; the stabilization of milk prices encouraged dairying; the manufacture of agricultural machinery within the Union following the establishment of the iron and steel industry stimulated the mechanization of cultural operations. The great impetus, however, came during and after the second world war when the growth in the urban population, associated with the expansion of industry, led to an unprecedented demand for foodstuffs. Moreover, during the war large quantities of meat, milk, and vegetables in processed form were required for the troops passing via the Cape and serving in North African and Asian theatres of war. The mechanization of agriculture took place very rapidly, particularly on the High-veld where the extensive level surfaces are exceptionally favourable. Whereas there were only 6,019 tractors in use in South Africa in 1937, by 1946 the number had risen to 22,292, by 1950 to 48,423 and by 1953 to 74,610. This mechanization of agriculture meant that trek-oxen were no longer required and so paved the way for the changeover to beef and dairy herds. The necessity of providing good grazing and concentrated foodstuffs for these animals on the one hand prompted efforts to improve the natural pasture and on the other led to rotation cropping and the establishment of leys of indigenous and introduced grasses. In this way the major cropping areas have become areas of increasingly mixed farming. Whether the emphasis is on grain or stock, on maize or wheat, on wool or mutton, on dairy produce or beef depends very much on the local conditions. At the same time specialization in the production of deciduous and citrus fruits is becoming more marked in those areas in which the climatic conditions are suitable and irrigation is possible. Large scale vegetable production and the growing of a great variety of tropical fruits are forging ahead in the Lowveld.

South Africa is no longer a country of very large farms. By 1945 over 60 per cent of the European farms were of less than 1,000 acres and 45 per cent of

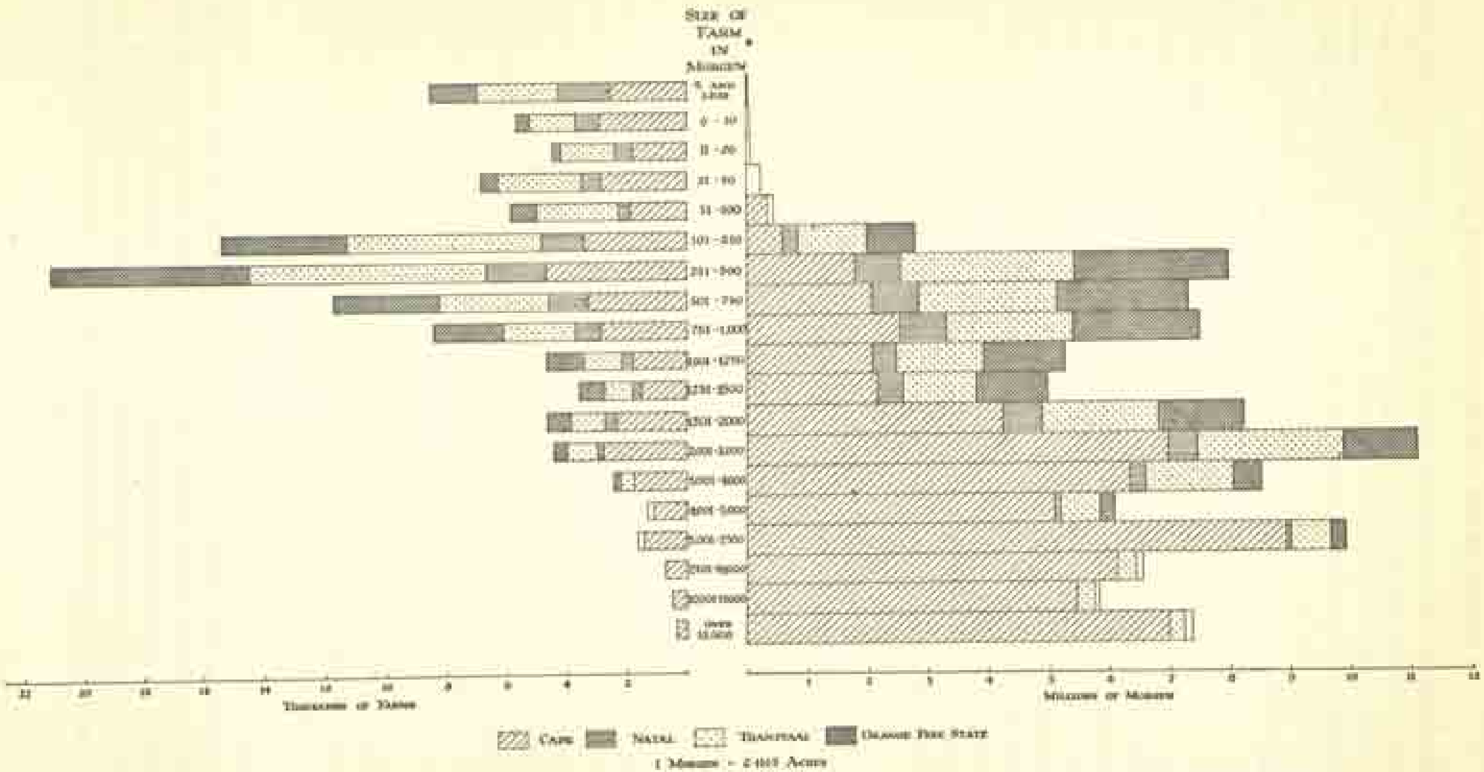


Fig. 58. Numbers of and areas covered by farms of given size in the provinces of the Union of South Africa. (1945–6 census.)

the European-owned part of the country was in farms of less than 4,000 acres (see Fig. 58). Very large farms are found today only in the semi-arid and arid country of the Karoo and Kalahari. In the Native territories holdings are everywhere extremely small. On European farms in all parts of Southern Africa the trend is towards more intensive agriculture. This is being considerably helped by the home production of fertilizers, particularly nitrogenous and phosphatic compounds; since the war South Africa has become self-sufficient in ammonium compounds and, with the exploitation of the phosphatic deposits near Palabora (see ch. 21, p. 340), will soon provide all her phosphatic fertilizer requirements as well. It is to be hoped that the Bantu in their turn will make fuller use of the fertilizers available to make their lands more productive.

9

The Cereal Crops

Of the cereal crops grown in South Africa maize and wheat are of outstanding importance, as may be seen from the following table.

Table 2. Union of South Africa. Acreage and production of cereal crops 1953–4

	Europeans		*Non-Europeans*
	*Acreage (thousand morgen)**	*Production (million bags)*	*Production (million bags)*
Maize	3,941	32·8	6·1
Wheat	1,191	5·8	
Kaffir Corn	185	1·1	1·1
Oats	399	1·3	
Barley	79	0·8	
Rye	65	0·7	

* One Morgen is equivalent to 2·1165 acres.

Maize

The Introduction of Maize and the Extension of its Cultivation

Maize is by far the most important crop in South Africa, in most years occupying nearly 7½ million acres out of a total cropped area of just over 10½ million acres. It was first introduced into the Cape in 1658 when seeds were brought by a slave ship from the Gold Coast.[1] There it was known as *milho* – the Portuguese for kaffir corn – from the time the Portuguese navigators brought it in from the West Indies. From this word the Afrikaans name for the crop – mielies – is derived. The Governor of the Cape – Jan van Riebeeck – had the new crop planted and cultivated by the West African slaves, but owing to the unsuitability of the climate of the south-western Cape for maize, little success was achieved and it was not until the summer rainfall area was reached by the European colonists a century and a

half later that the crop became important. The English settlers began its cultivation in the eastern Cape and thence it was taken to the Bantu areas where it displaced kaffir corn as the principal crop. The Voortrekkers carried maize northwards over the plateau, where, however, the unsettled conditions and lack of transport facilities discouraged its cultivation for other than immediate domestic needs during the pioneering days. With the growth and concentration of people in urban centres which accompanied the exploitation of mineral wealth at Kimberley and on the Witwatersrand, however, the position changed. Large markets for agricultural produce developed and maize was particularly in demand for the African mineworkers, whose staple diet it had become. This stimulated the farmers in Natal, the Orange Free State, and the Transvaal to go in for commercial maize farming.

Progress was most rapid in Natal, where the Africans were already familiar with the crop and adequate and reliable rainfall resulted in bigger and more certain crops than elsewhere. At first the Highveld farmers lagged behind; descended from generations of stock farmers they did not take readily to arable cultivation and in the absence of nearby Native Reserves, labour was scarce. The mines, therefore, imported maize from Natal. When, however, in the last decade of the century, maize was taken up on the Highveld, production increased so rapidly that when the Anglo-Boer war broke out in 1899, the Transvaal was already self-supporting. The war caused a serious setback but thereafter expansion was rapid. By 1907 Natal had a surplus of 1½ million bags, and unable to find a market for it in the Transvaal, made the first export to England. This was highly successful. At once the farmers of the Transvaal and the Orange Free State increased their acreages under the crop and in 1908, in anticipation of an important export trade, regulations regarding export and grading were framed and reduced tariffs introduced by the railways and the shipping companies. In 1909 1½ million bags were exported, mainly from the Transvaal and the Orange Free State whose combined production had already outstripped that of Natal.

The period of initial expansion came to an end with the outbreak of the first world war and for the next six years the production from the European farms stabilized at around 9 million bags; the Non-European producers accounted for a further 2 to 3 million bags. Each year between 1 and 2 million bags were exported. After the war the increasing world demand and high prices on the one hand and Government encouragement on the other led to a considerable increase in maize growing particularly in the western Transvaal; but as maize growing spread into areas less suited to it, the yield fluctuated violently as years of good rains were followed by years of drought. In the 1922–3 season the crop approached 20 million bags, in the following year it was little more than 11 million bags; in 1924–5 a record yield of over 24 million bags was obtained but this was succeeded by one of less than 11 million bags (Fig. 59). At the same time while there was a general overall increase in the export of maize the amount varied between 1 and 9 million bags according to the size of the crop.

In order to regulate export and permit the storage of grain after good harvests as an insurance against poor ones, large elevators were erected, in 1924, at Cape Town and Durban docks and at thirty-three stations in the most important maize producing areas. This further stimulated maize growing. Thereafter production steadily increased and despite increasing home consumption an export was maintained until the outbreak of the second world war.

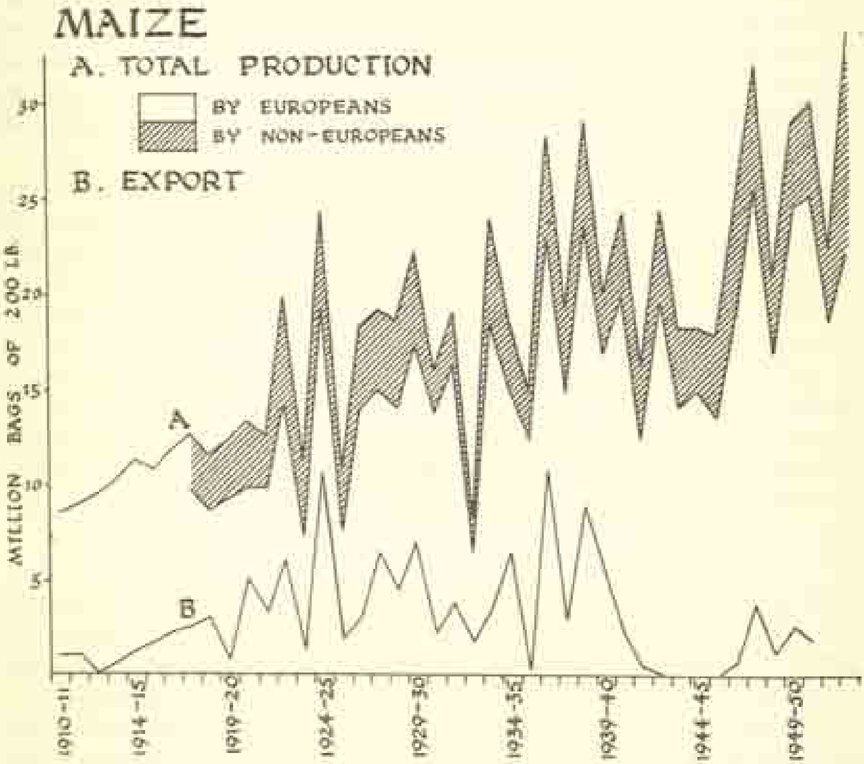


Fig. 59. Maize production and export 1910–53.

The influx of people, particularly Non-Europeans, into the towns which accompanied the expansion of industry during the war and immediate post-war years led to a considerable increase in the home consumption of maize. At the same time drought and shortages of fertilizers resulted in poor harvests. In consequence demand actually exceeded supply and from 1945 to 1947 it was necessary to import maize. The shortages, however, encouraged farmers in the marginal areas, particularly the north-western Orange Free State, to increase their acreages. During the past five years the output from Europeans' farms has averaged about 20 million bags and from all farms 24 million bags – five times that of wheat – and South Africa has again become a maize exporter. The value

of the crop has averaged £27 million, second only to wool among the agricultural products of the country.

The Main Maize-growing Areas

The most important maize-growing area in South Africa (Fig. 60) is the so-called maize triangle. Bounded by Mafeking and Vryburg in the north-west, Ermelo in the east and Wepener in the south, the maize triangle is remarkably sharply defined. It lies at an elevation of more than 4,000 feet on the Highveld plateau within the area experiencing a warm temperate continental type of climate and possessing Highveld Prairie soils. Its western boundary approximately coincides with the 20-inch annual isohyet and a change to sandy and alkaline soils in the south-west (Fig. 61). The northern limit is the edge of the Highveld beyond which high summer temperatures (note the January mean maximum isotherm of 85° F., Fig. 61) reduce the effective rainfall, streak disease is prevalent and, except on the Springbok Flats, broken country and poor soils limit extensive cultivation. In the east production tails off as cooler, wetter summers are experienced with increased elevation towards the Drakensberg, the limit more or less coinciding with the January mean minimum isotherm of 55° F.

Below the Drakensberg Escarpment the crop is widely grown both by Europeans and Africans in Natal and the eastern Cape but in the Natal Midlands the cool misty summers are unfavourable and near the coast other crops are more profitable. The crop is important on the Springbok Flats and is grown to a limited extent in the Bushveld and Lowveld.

The Maize Triangle

Although countless divergent varieties of maize permit its cultivation within a wide range of climatic conditions the plant is essentially a warm weather one requiring high temperatures both day and night during the growing season. Over the South African plateau the climatic conditions are somewhat marginal for maize, production being adversely affected by rather low temperatures and unreliable rainfall. This is best appreciated by comparing the optimum requirements of the plant with the climatic conditions over the Highveld.

The Climatic Requirements of the Maize Plant. For successful grain production maize requires a mean temperature of at least 66° F. during the three summer months while it yields better crops when the means are between 70° and 80° F.; its germination and growth are retarded if the mean nightly minima are less than 55° F. and for normal development minima above 58° F. are preferable; the plant flowers and ripens much sooner when the temperature maxima are nearer 80° than 70° F. but extremely high temperatures especially when accompanied by deficient moisture may be injurious particularly at the tasselling stage when extreme desiccation may kill the silks and tassels and prevent pollination.

Between 25 and 50 inches of rainfall a year are normally regarded as necessary for maize production but much depends on its distribution and intensity and on

the prevailing temperatures. Under optimum conditions 8 inches during the three summer months is the minimum while the highest yields are obtained when between 3 and 6 inches, evenly distributed, are received each month. The crop requires abundant sunshine while it is injured by hail, wind, and freezing conditions. The length of the growing season varies with the variety; of the two main types the dents require anything from 120 to 190 days to come to maturity and the flints only from 90 to 120 days.

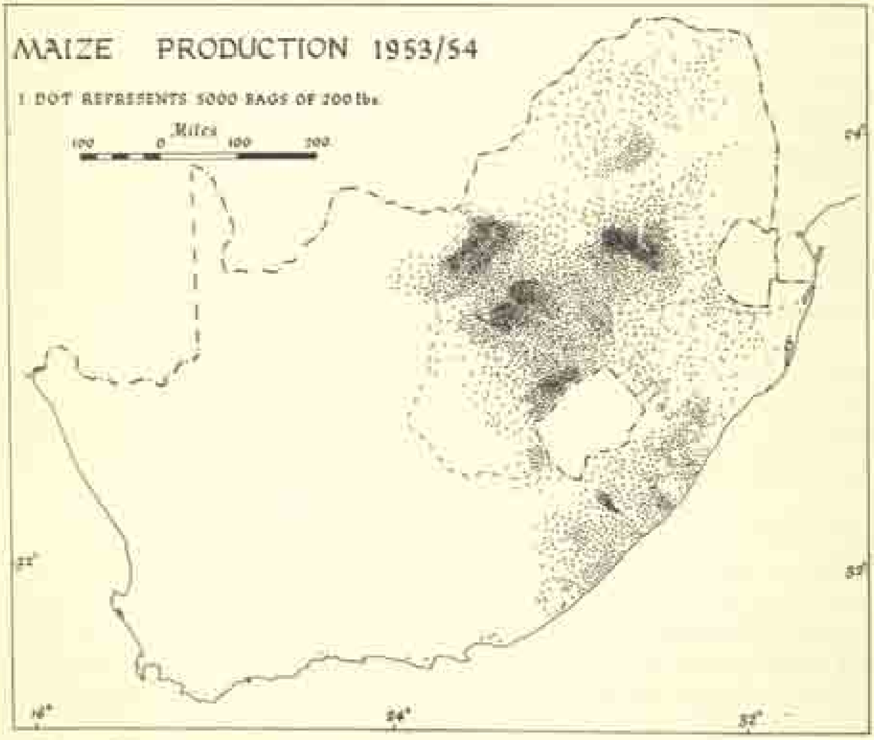


Fig. 60. The distribution of maize production in the Union of South Africa. (1953–4 agricultural census.)

The Climatic Conditions in the Maize Triangle. There are considerable differences of temperature and rainfall between the eastern and western parts of the maize triangle.

In the eastern part of the maize triangle the summer temperatures are decidedly low for grain production. At Bethal and Standerton the mean temperatures are only 63° to 69° F. and the nightly minima between 47° and 55° F.; moreover minima below 40° F. are normally experienced on a number of occasions each year. The daily maxima, usually between 77° and 83° F., are favourable and very high temperatures are rare, but the daily range, 25° to 30° F.

is great and exerts a strain on the plants. In the centre of the belt (at Kroonstad), the mean temperatures are some 3° F. higher but low nightly minima may still be experienced. Towards the west mean temperatures vary between 69° and 77° F. (at Lichtenburg, Mafeking, Vryburg, and Bloemhof), and low minima in early summer are unusual, but excessively high temperatures combined with conditions of low atmospheric humidity frequently occur; moreover the rains are often late and low autumn temperatures may spoil the crop before it is ready for harvest.

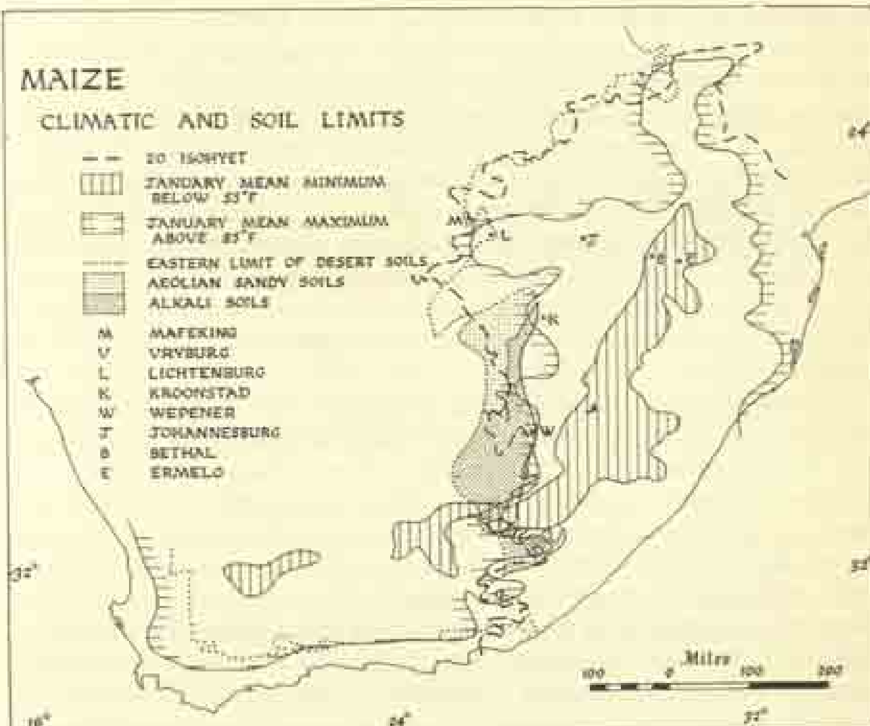


Fig. 61. Climatic and soil factors affecting the cultivation of maize.

Throughout the main maize producing area the rainfall averages between 20 and 40 inches, the total fall generally decreasing in a westerly direction. Most of the rain occurs in thunderstorms coming towards the close of warm, sunny summer days. Its nature and time of occurrence is favourable allowing for a maximum amount of sunshine, but unfortunately it is unreliable both in amount and incidence. The yearly total varies considerably and drought periods of more than two weeks occur during the growing season in most years, even in the better watered areas; westwards these irregularities become more marked as the annual total decreases.

Thus the temperatures generally become more favourable for maize cultivation towards the west, but the rainfall decreases and becomes more unreliable. In the east the rainfall is adequate but low temperatures retard growth. The growing season exceeds 150 days in the centre of the maize triangle but is less than 120 days along the Basutoland border and again in the west. Here it is only just long enough for the quicker maturing varieties of maize.

Climate and Stages of Growth in the Maize Plant. The maize plant has certain minimum requirements at all stages of its growth. By the end of October the temperatures throughout the maize triangle are sufficiently high for planting to take place but the date of commencement of this operation depends on the accumulation of adequate moisture in the soil. Normally about 4 inches accrues in the four to five months period from the previous harvest, which usually takes place in May, but in addition at least 2 inches of rainfall are required before planting. In the eastern part of the belt the first good rains usually occur in October and normally more than 3 inches are received during each month from October or November to March. In the west, however, good rains are frequently not experienced until January.[2] In consequence, whereas planting may extend over several weeks or even months in the east, it has to be crammed into a short period in the west. Moreover should inclement weather destroy the first planting, in the east there is still time for a second to mature; in the west this is not possible.

Little rainfall is required during germination and early growth and the tendency towards a falling off in the rainfall during December, which is characteristic of the Transvaal, is actually beneficial.[3] The water requirements of the plant increase as growth proceeds and are critical immediately before and after flowering, particularly during tasselling* and silking,† if successful pollination is to be effected.[4] This normally takes place in late January and early February when, unfortunately, droughts of two weeks or more are frequent even in the east. More than any other factor these droughts at the critical period of growth have a depressing effect on crop yields.[5] After pollination a relatively dry period is desirable but adequate moisture is necessary for translocation. Thereafter dry weather is beneficial for bringing the crop to maturity and lengthening the harvest period. Normally the harvest may be spread over one month to six weeks, there being little danger of early frosts before June, but in the west, where the growing season is shorter, the period available is much less. In that area too the rainfall during the growing season is barely sufficient while losses due to high temperatures and low humidity occasioned by hot dry winds from the Kalahari are often considerable.

* The tassels bear the anthers with the pollen. The germinability of the pollen grains is usually well maintained for twenty-four hours. Usually a tassel takes four to ten days to shed its pollen, but since not all plants flower at the same time, pollen is usually present in a field for about three weeks.

† The silk comprises the stigma and style, and is usually receptive of pollen for three weeks, although becoming markedly less so after the tenth day.

The Soils of the Maize Triangle. Over the greater part of the maize belt the soils are of the Highveld Prairie type* (see ch. 4, p. 82). They have a good structure, but are only of moderate fertility, being fairly well supplied with potash but somewhat deficient in lime and phosphoric oxide. The best soils are the intrazonal black clays, derived from intrusive dolerite, found particularly near Bethal and in the western Free State. Although they are somewhat difficult to cultivate,

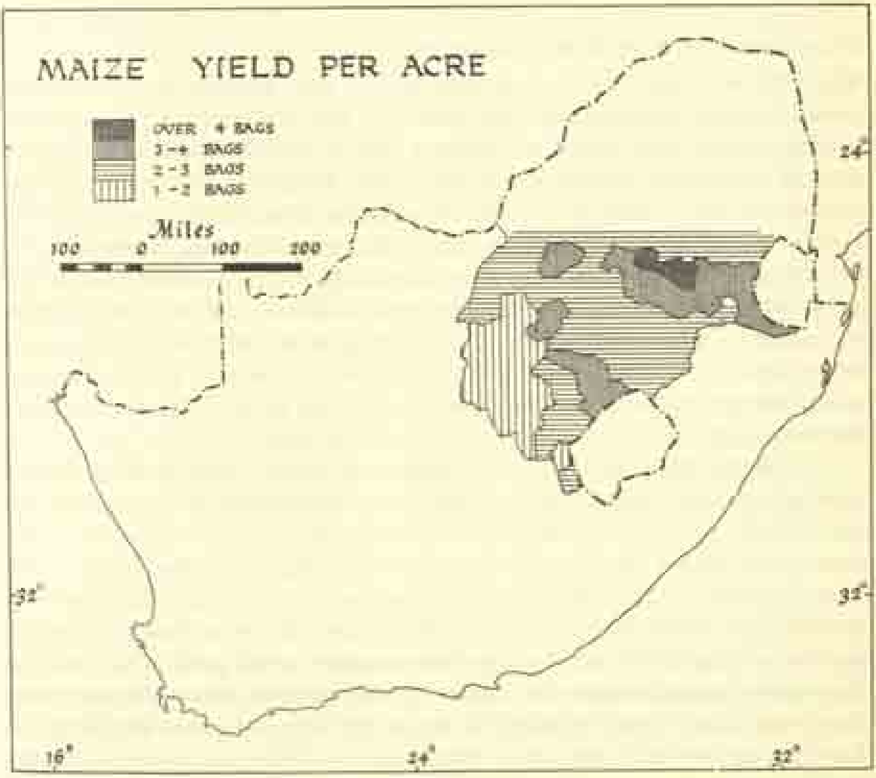


Fig. 62. Maize yield per acre on European farms in the Union of South Africa. (Compiled from an analysis of the statistics given in the agricultural censuses 1920/1–1949/50.)

becoming very sticky after rain, their relatively high content of soluble salts, particularly calcium, makes them more productive than other Highveld soils.

Maize Yields. Largely because the climate is marginal for maize grain yields are low, in fact among the lowest in the world. In the west the low and unreliable rainfall results in uncertain crops and in the east the low temperatures are not conducive to big crops. Over the greater part of the plateau only 2½ to 3 bags* per acre are obtained in most years (Fig. 62) and even in Bethal, the best maize

* One bag of 200 lb. This is approximately equivalent to 1⅞ bushels.

district, only 5 bags is usual. Towards the west yields drop to 1½ bags. Moreover the yield varies considerably from year to year; thus the 1927–8 Bethal crop averaged over 7½ bags per acre but was followed by one of only 2½ bags, while the biggest yield in Lichtenburg, 4½ bags in 1949–50 was six times the lowest, less than ¾ bag in 1923–4. These low yields, however, are to some extent offset by the excellent quality and keeping quality of the grain consequent on the dry atmospheric conditions.

Recent Developments in Maize Cultivation

While the low maize yields are undoubtedly in large measure due to marginal climatic conditions, the use of unsuitable seed and poor cultural practices have also played their part. Maize monoculture without the application of manure or artificial fertilization has led to soil exhaustion; inattention to weed control has robbed the maize plants of available soil moisture; insect pests, particularly the stalk borer, and in the more humid eastern areas fungal diseases, particularly dry rot (*Diplodea zeae*) and fusarium rot (*Giberella* spp.), have destroyed part of the crop. All have depressed yields. Since 1939, however, with the use of maize varieties bred especially for South African conditions and with the introduction of better cultural practices, there has been some improvement in the yield. At the same time the spread of mechanization, by speeding up the cultural operations, has reduced the hazards particularly in the western areas.

Formerly American varieties of maize were used; 'Hickory King' with a growing season of 150 days was a popular White Dent variety in the centre of the belt and the Yellow Flint, 'Boerman', maturing in 120 days was grown in the eastern Free State, where the growing season is short. Varieties suited to the drier areas were lacking. Today, however, as a result of the plant breeding work carried out in South Africa, particularly at Potchefstroom Agricultural College, a number of excellent White Dents are now available for all parts of the belt and increasingly each area grows the variety best suited to it. Thus 'Potchefstroom Pearl' and 'Early King' maturing in 125 to 130 days are grown mainly in the Lichtenburg and Bothaville areas where they outyield other varieties; 'Silver King' leads in the Bethal – Standerton area, and 'Mic Success' in the Heidelberg–Springs area; 'Improved Anveld' which matures in 115 to 120 days and is resistant to drought is popular throughout the belt. Increasing attention is being given to hybrid maize[7] and already yields of more than 25 bags per acre have been obtained in field experiments. As yet, however, there is insufficient seed for general distribution. Here South Africa lags well behind the U.S.A. where already by 1943 more than 80 per cent of the crop came from hybrid corn.

Increased mechanization and improved farming practice have gone hand in hand. Tractors have speeded up the ploughing operations. With machinery planting is effected in a shorter period. Recently too a mechanical corn picker has been developed in South Africa and proved particularly valuable in the western

Transvaal where it is vital to harvest the crop before it is damaged by wind or cold. In this area mechanization has also made possible measures for the conservation of soil and moisture. The most interesting of these is the close planting of maize in rows 7 feet apart instead of the normal 3 feet. This permits cultivation between the rows in order to keep down weeds in the early stages of growth of the maize plant, and enables wheat, oats and rye to be grown between the rows in February and March in order to provide winter feed for stock. This provides a winter cover for the ground and introduces some rotation while at the same time increased maize yields have been obtained. Farther east crop rotation is increasing and higher maize yields have been obtained when the crop has followed a legume such as cowpeas or soybeans, a grass hay crop, or heavily fertilized potatoes. With good cultivation on well-fertilized soil record crops of more than 16 bags per acre have been obtained on the Highveld and of more than 30 bags per acre in the warmer districts of Lydenburg and Piet Retief.

Thus while certain geographical conditions limit maize production in South Africa and cause poor and fluctuating yields, it seems probable that, with varieties better suited to the environment and improved farming practices, a greatly increased production is possible.

The Areas of Heaviest Production. Within the maize triangle four areas stand out as centres of heavy production (Fig. 60) – the Bethal district, the north-western part of the Orange Free State, the area around Lichtenburg and the Caledon river lands. The first mentioned has long been the leading maize producing area of the Union, its heavy production being due mainly to relatively favourable climatic conditions and good soils. By contrast the north-western Free State has become important only since the introduction of drought-resistant varieties of maize and the mechanization of cultural operations. Its production has increased by more than 50 per cent since 1939. The area around Lichtenburg, although long important for maize, has likewise experienced a considerable expansion for similar reasons. Here, however, the heavy production is due less to favourable geographical conditions than to the fact that farms are small relative to the agricultural potentialities of the land. In consequence their owners are forced to devote a larger proportion of the acreage to a cash crop – of which maize is the most suitable – in order to obtain an adequate income, than is desirable. Were the farms larger no doubt a higher percentage of the land in this area would be left as grazing. The fourth area of heavy production, in the eastern Free State, is one of relatively high yields associated with fertile soils derived from an admixture of sandy and basaltic material washed down from the neighbouring Basutoland mountains.

Future Trends. During the present century maize cultivation has continually pushed into the drier areas of the Highveld plateau until today a major portion of the crop comes from specialized grain farms near the western limit of production. In the east increasing attention is being given to a more mixed type of farming and while yields may increase a reduction in acreage is to be expected and more of

the crop is likely to be fed to stock. It is possible that the breeding of new drought-resistant varieties of maize will permit its cultivation in still drier areas but the present western limit of production coincides with a change to soils which are inclined to blow when robbed of their vegetative cover. In the Bushveld and Lowveld the temperatures are suitable for maize and in some areas the rainfall is adequate for drought-resistant varieties. The main limiting factors are the prevalence of streak diseases[8] and the difficulties of clearing land heavily bushed and frequently hilly. These are difficulties which, however, are likely to be overcome with the breeding of new maize varieties and use of mechanized cultural methods and it is, perhaps, from the Bushveld especially, that any increased production is most likely to come.

Wheat

The temperate cereals – wheat, barley, oats and rye – are grown almost exclusively during the winter months and are commonly called winter cereals. Of these wheat is by far the most important.

From the days of the first settlement wheat was grown in the south-western Cape in order to meet the needs of the relatively small local population and to provision passing ships. The production remained small until the latter part of the nineteenth century when the great increase in population following the opening of the Kimberley diamond fields and Witwatersrand gold mines created a greatly enlarged home market. At once the acreage under the crop in the south-western Cape was extended while new producing areas developed in the Transvaal and the Orange Free State. At first the South African wheat farmer, enjoying the advantages of proximity to market, prospered but with the development of extensive mechanized wheat production in Australia, Canada, and the U.S.A. and the advent of cheaper ocean transport, following the introduction of steam ships, he found it increasingly difficult to compete. From the first settlement active steps had been taken to make the Cape Colony self-supporting in wheat and the wheat farmers had been protected from time to time by small duties on imported wheat. After Union they were aided by a preferential railway tariff for home produced grain.[9] During the first world war production was stimulated by high prices and the fear of a bread shortage but thereafter and until 1929 the acreage remained more or less static at around 400,000 morgen (850,000 acres) giving an average annual production of 2 million bags.* This furnished only about 70 per cent of home needs and it was necessary to import the balance.

Following the collapse of world wheat prices in 1929, the South African wheat farmers were accorded protection by means of a customs duty making it impossible to import wheat for less than 22*s.* 6*d.* per bag and by the imposition of a maximum railway rate on wheat and flour. This greatly stimulated production for, with an assured home market, wheat farming became an attractive proposition at a time when the sharp fall in world prices during the Great Depression

* One bag of 200 lb.

made wool and maize production for export less profitable. After 1939 the second world war and the growing home demand, associated partly with the tendency for urban Natives to substitute wheaten bread for maize in their diet,

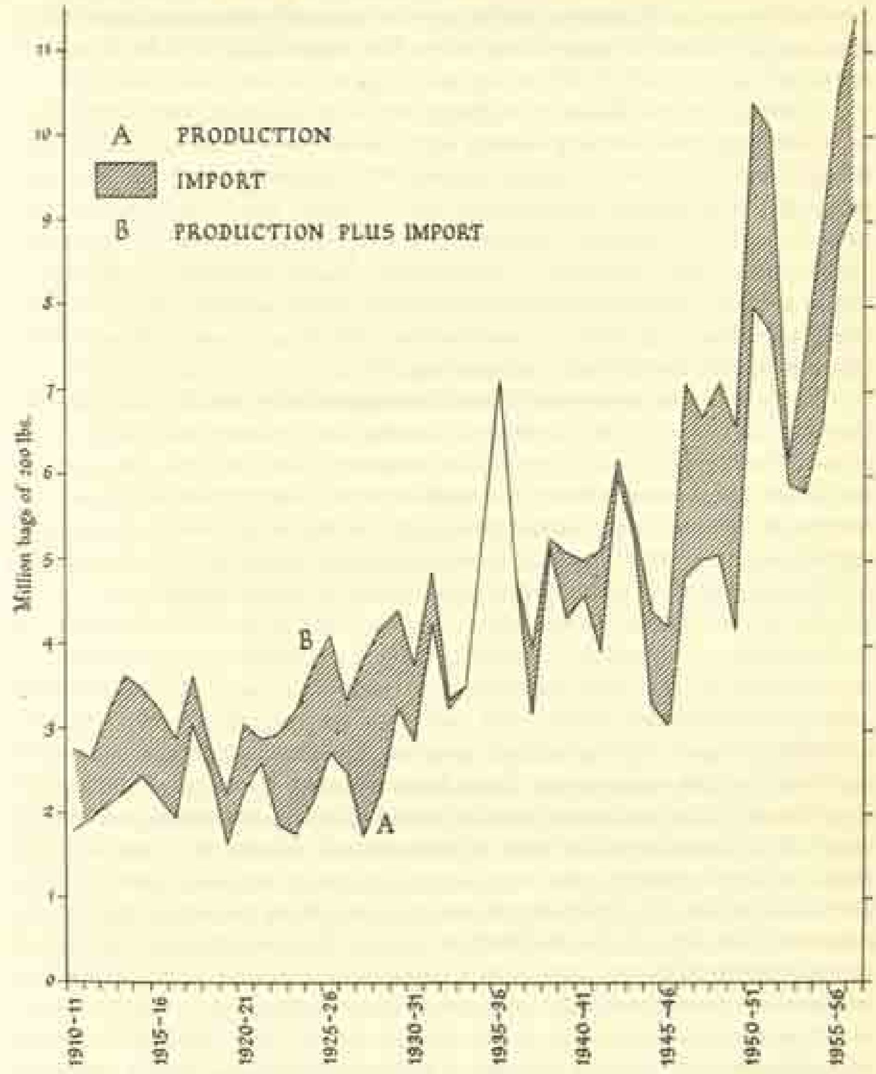


Fig. 63. Wheat production and import 1910–56.

necessitated increased production. To achieve this, as a matter of national policy, the subsidies begun in 1930 were steadily increased to the 1952 rate of 10*s.* 3*d.* per 200-lb. bag of bread flour and 20*s.* 9*d.* for sifted meal, the 1952 price for

class A wheat being 50*s.* 11*d.* per bag. At the same time the completion of irrigation works prepared the way for wheat production in the Transvaal Bushveld and the breeding of new varieties enabled the Highveld farmer to take up the crop. As a result of all these factors the wheat acreage and production have more than doubled since 1929. Whereas prior to 1929 the crop only twice exceeded 3 million bags, since then it has never fallen below this figure (Fig. 63). In the 1935–6 season it reached nearly 7 million bags and in 1950–1 exceeded this amount.

The physical conditions are nowhere very good for wheat production. There are no vast expanses of rolling country with a favourably distributed rainfall such as characterize the North American prairies or the Argentine Pampas. Where the temperatures are suitable the rainfall is low and erratic, and the soils are generally poor. The most important producing area (Fig. 64) lies in the south-western Cape which normally accounts for 2 to 3 million bags of an average production of 4½ to 5 million bags. The irrigated valleys of the Transvaal Bushveld contribute a steady 1½ million bags while the eastern Free State is an erratic producer, sometimes yielding between 1 and 2 million bags but in years of unfavourable rainfall practically none. In some years there is an appreciable contribution from the flood irrigation area of the Karoo and from the north-eastern and 'border' districts of the Cape Province. Everywhere production costs are high and yields are low. The more favoured areas of the south-western Cape average only 6 bags per morgen or 10 bushels per acre and the marginal areas only 2½ bushels. Even in the irrigated valleys of the Transvaal the average is only 15 bushels. But for Government protection many of these areas would go out of wheat production.

In the south-western Cape wheat is grown where level or undulating land is fairly extensive, the rainfall is adequate, the soils are relatively deep and capable of supporting a wheat crop and lack of opportunities for irrigation precludes more profitable fruit crops. The relief is suitable in the western and southern lowlands and in limited areas in the mountain basins and along the valleys of the major rivers. Here the temperatures are generally favourable, the means for the spring months exceeding 57° F. except in some of the mountain basins where frost may be experienced. Rainfall is a more limiting factor. Generally speaking the total increases eastwards from less than 10 inches north of St Helena Bay to between 20 and 30 inches in the mountain basins. More important however, is the distribution, at least 8 inches during the growing season from April to September being required for dry-land wheat production. In the western areas practically all the rainfall comes during this period but eastwards an increasing proportion is received in summer. The limits of the wheat belt approximately coincide with the 8-inch growing season isohyet extending north-westwards as far as St Helena Bay and eastwards to the Gouritz river. Within this area the rainfall varies from year to year and crop failures are frequently experienced in the marginal zones. Better crops are obtained where the rainfall during the growing season exceeds 10 inches and where the fall during the seed time and germination period, April–May, and the period of active growth,

August–September, is most reliable. Generally speaking the 'former' rains exceed 3 inches and the 'latter' 4 inches, adequate for a good crop. The spring or 'latter' rains are usually more dependable than the autumn rains, while the reliability of both decreases towards the north-west and west.[10]

Within the south-western Cape wheat is produced in six distinct geographical sub-regions, differing from one another in relief, rainfall distribution, soil type and agricultural economy. These are the Swartland and Sandveld of the western lowland, the valleys and mountain basins, and the Rûens, Duineveld and Lower Langebergen of the southern lowland. In the valleys and mountain basins it is grown only on land which cannot be reached by irrigation water; and while the favourable rainfall distribution ensures a steady acreage and reliable production, wheat is of considerably less importance than fruit. The oldest and most important producing area is the Swartland, but since 1930 the acreage has expanded considerably in the Sandveld, Rûens, and Duineveld and more recently in the Lower Langebergen.

The Swartland is climatically the best wheat area. The rainfall during the growing season usually exceeds 14 inches and is fairly reliable, while there is little danger of late spring rains which would hamper harvesting and favour rust. In other directions the area has a number of shortcomings. The relief is that of a level or moderately sloping surface cut into by steep-sided river valleys. The soils, derived from the Malmesbury slate, are mainly gravelly sandy loams from 8 to 15 inches deep overlying a heavy impervious pot-clay. They are naturally poor in nitrogen and phosphate and require heavy fertilization both with organic material such as cereal straw and chaff, kraal manure and guano (obtained off the coast to the north-west), and with artificials; they are rather poorly drained and after heavy rains, due to their high content of fine sand and low content of humus, they tend to compact.[11] In consequence they are prone to sheet erosion. Formerly sheep rearing provided the main source of income in this area; the area cultivated was limited; a crop of wheat was followed by one of oats after which the land was rested for a number of years and the fertility built up as the volunteer grasses and other plants, which sprang up amongst the stubble, were grazed.[12] But high prices for wheat have led to a shortening of the rotation to wheat, oats, 'oldland' for grazing, cultivated fallow, and to an extension of grain cultivation on to increasingly steep slopes, even to those of one in four. This has resulted in soil depletion, serious sheet and gully erosion (see Plate 92) in many places and declining yields. Today the farmers are faced with the problem of how to restore their exhausted land. Some success has been achieved with dryland lucerne which fixes large quantities of nitrogen in the soil and also provides good grazing for livestock, but because its inclusion in the crop rotation involves a lengthening of the rotation and loss of potential income from wheat it is not as yet widely grown.

The Sandveld consists of a level coastal plain of marine and aeolian sands, in places diversified by ridges and sand hills built up by strong southerly winds. The rainfall during the growing season averages only 10 inches. In the coastal areas

the soils derived from the sands overlying limestone are relatively rich in nitrogen, phosphates, potash and lime, but they have a poor water retaining capacity and their loose nature makes them highly susceptible to wind erosion. Near Vredenburg soils of good structure and relatively high fertility have weathered from the granite. In this sub-region wheat production is limited by inadequate rainfall and most of the land is in grazing. Nevertheless wheat production has

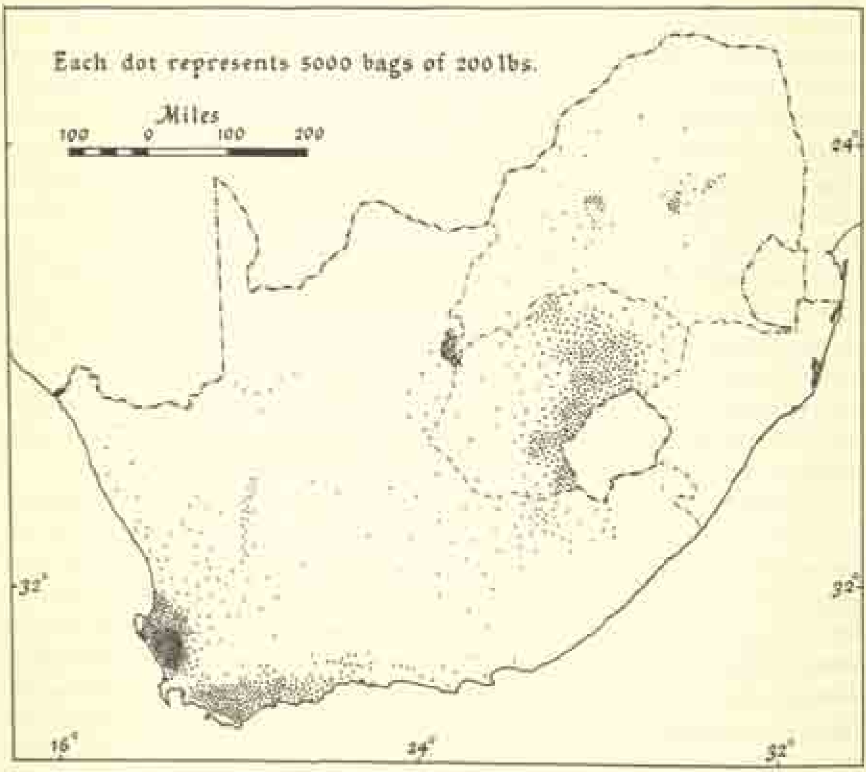


Fig. 64. The distribution of wheat production in the Union of South Africa.
(1953–4 agricultural census.)

expanded and constitutes the main source of income. But, despite heavy applications of fertilizer, the soils have deteriorated rapidly under cultivation and severe wind erosion has followed especially in the coastal area near Langebaan, where in places the limestone subsoil has been exposed. Wheat yields are lower than in the Swartland but the quality of the grain is usually high. But for tariff protection this area would revert to grazing.

The Rûens is the second most important wheat producing area (see Plate 93); of more recent development than the Swartland, it was first settled by pastoralists coming over the Hottentot Holland mountains. It lies east of the

Houwhoek mountains and south of the Rivier Sonder Einde bergen and extends southwards to the Duineveld. The surface is generally undulating, but is broken by the Caledon–Bredasdorp range running from west to east; these features are responsible for the name Rûens – or ridge lands. The winter rainfall averages 11 inches, which is adequate for wheat cultivation, but there is a tendency for rain to occur in late spring or early summer when it encourages the spread of rust. The soils, derived largely from Bokkeveld shales, are generally superior to those in the Swartland. They are gravelly sandy loams overlying clayey sandy loams, have a good water retaining capacity and are of high fertility, being fairly rich in organic material, in nitrogen and potash, although low in phosphates. On most farms there is more pasture and less cultivated land than in the Swartland; but there is little difference in the acreage under crops for the land is rested to a lesser extent. In fact less than one-half is rested annually and in some cases wheat is followed by another crop of wheat or one of oats before the year of fallow. The higher fertility of the soil makes this possible even with smaller applications of fertilizer than is usual in the Swartland. In places continuous cropping on steep slopes has caused soil erosion, but this is less serious than in the Swartland or Sandeveld. Nevertheless the inclusion of dry-land lucerne in the rotation would be beneficial. The production costs are lower here, consequent upon more fertile soils and a higher degree of mechanization; yields equal those of the Swartland, but owing to the more humid conditions in early summer the grain is of poorer quality.

In some ways the Duineveld resembles the Sandveld, being for the most part a low-lying belt of dune sand over limestone, characterized by soils which are easily blown by wind. Much of the land is left in grazing. Wheat cultivation is important only south of the Bredasdorp mountains where sandy loams derived from Malmesbury slate occur. The proportion of land under cultivation here is smaller than in the Rûens and wheat is only a little more important than sheep as a source of cash income. This is due mainly to unsuitable soils and less favourably distributed rainfall; the December falls and generally high humidity favour the spread of diseases, while the evenly distributed rainfall supports better pasture. Nevertheless a close rotation of wheat, oats and fallow is practised on the cultivated lands, which are given only a short rest period.

The Lower Langebergen continue the main features of the Rûens and Duineveld. On the whole the surface is undulating. The rainfall from April to September is unreliable and often inadequate while the weather is frequently too wet from October to December for a good harvest. Rust often damages the crops. Consequently wheat production is precarious. The Lower Langebergen has always been a sheep farming area, but high wheat prices led farmers from the Rûens to extend their operations into this area while share-croppers sought arable land on the large ranches. This resulted in a phenomenal increase in the acreage under wheat despite low and unreliable yields and poor quality crops. The recent high prices in wool have started the swing back to sheep farming but

so long as wheat prices remain high the capital invested for its cultivation and the fact that the land has been ploughed will bolster its production despite unsuitable geographical conditions.

Thus in the south-western Cape only the Swartland and the Rûens are really suited to wheat production, and even here cultivation has extended on to lands too steep for the plough, while wheat crops succeed one another too quickly. The other areas are definitely marginal. In all areas early maturing varieties are grown owing to the prevalence of strong winds in early summer which cause shattering. Generally speaking the climate is healthy for wheat, but rust occurs in the southern lowland where only resistant varieties can be grown. Except in the Lower Langebergen the operations are highly mechanized. Mules are still extensively used for draught purposes but tractors are increasing, self-binding reapers are generally used and combines have appeared.

Wheat production in the eastern Orange Free State differs markedly from that in the south-western Cape. Here it is grown mainly in the long disputed Caledon river lands. Towards the Drakensberg the land becomes too uneven for tilling and the soils too shallow, while to the north and west less rainfall is experienced in autumn, winter and spring and the soils become shallower, less sandy and less cool. The arable land lies in the valleys and basins of the mountain foothills; in places these are narrow but elsewhere they assume the form of plains. The area is crossed by many streams, but the depth of their valleys makes irrigation unfeasible and dryland farming is the rule. The area lies within the summer rainfall belt but an appreciable amount falls in autumn and sometimes good rains occur in winter. For wheat production the amounts received from March to May and from August to October are critical. The former rains average 6 inches and the latter 4 inches but they are very unreliable, the coefficient of variation being more than 40 per cent. The winters are bitterly cold and frost occurs to the end of August but the mean temperatures from September onwards exceed 56° F. and are sufficiently high to ripen the grain. The soils are deep sandy loams which are retentive of moisture and remain damp for a long time, thereby tiding a crop over a relatively dry season. Wheat has been grown in this area since the old Republican days and in common with other areas the acreage has increased since 1930. However adequate autumn rains are vital and hence the acreage and still more the production fluctuate violently from year to year. In this area wheat is used to a considerable extent as winter grazing, especially for lambing ewes and for cows, and only after the sheep have been tided over is it allowed to run to seed. As a result yields are generally low, averaging only 5 bags per morgen in a good year and frequently less than 2 bags.

In the Transvaal Bushveld wheat is grown as a winter crop in rotation with summer crops of tobacco and sunnhemp on valley lands commanded by irrigation schemes. The acreage has increased as government works such as Hartebeestpoort and Loskop have been completed. The crop fits well into the rotation, but it is liable to suffer damage from early summer hailstorms. The Union tobacco

production is now more than adequate for the home market, and since wheat cultivation is related to tobacco growing, any expansion is unlikely; there may be a contraction of acreage as the valuable land is increasingly turned over to more intensive use and more profitable crops.

Prior to 1930 most of the wheat produced in South Africa was low in protein content and of poor baking quality.[13] The imported wheat was mainly of high quality for blending purposes. Since 1930 the cultivation of improved varieties and the scientific application of nitrogenous fertilizer have done much to raise the quality of the South African grain but it is still desirable to blend small quantities of high quality imported wheat with it. This is the only import permitted.

Other Cereal Crops

Compared with maize and wheat other cereal crops are relatively unimportant. Of those grown kaffir corn and oats occupy the largest acreages (see Table 2).

Kaffir corn (Plate 137) is a sorghum, indigenous to southern Africa and was cultivated by the Bantu for grain and for beer making long before the coming of the European. With the introduction of maize it lost its place as the grain crop in the Bantu economy and today is grown by the Native mainly for malt for Kaffir beer. As a food crop it is now grown only in the more arid westerly parts of the summer rainfall belt where its drought hardiness assures a crop where maize would fail. The main reason for the eclipse of Kaffir corn is its susceptibility to bird injury and aphis attack. Recently, however, with the development of mechanical methods of handling the crops European farmers have taken up the cultivation of dwarf sorghums on the Springbok Flats.

Oats are grown mainly in the wetter parts of the wheat belts of the Cape and in the eastern Free State. The bulk of the crop is for grain but in certain districts a fair amount of oat hay is produced for feeding to horses and mules. Most of the grain is used in various forms of stock feeds but some is now being used in the preparation of breakfast foods. In those areas receiving some winter rainfall the value of oats as a winter grazing crop is becoming more generally recognized and increasing acreages are being sown for this purpose.

Although the total acreage devoted to *barley* is small in some parts of the country it is an important crop. In some districts it is grown for grain, in others for grazing purposes; elsewhere green barley is produced for soiling purposes and it is sometimes used as a green manure. In a few dry districts – i.e. the Breede river valley, the Ladismith and Van Rhynsdorp areas of the Cape and the Steelpoort valley of the Transvaal – high quality barley is produced under irrigation for malting purposes. The main acreage, however, is in the wheat belt of the south-western Cape.

BIBLIOGRAPHY

MAIZE

1. P. W. VORSTER. 'The Maize Industry'. *F. in S.A.*, Vol. XXVII, Mar. 1952, pp. 171–6.
2. F. E. PLUMMER and H. D. LEPPAN. *Rainfall and Farming in the Transvaal.* Transvaal University College, Bull. No. 12. 1927.
3. D. G. HAYLETT. *Preliminary Study of Crop Yields and Climate in the Transvaal.* Transvaal University College, Bull. No. 19. 1930.
4. See A. R. SAUNDERS. *Maize in South Africa.* South African Agricultural Series, No. 7, Central News Agency. 1930.
5. Analysis of crop yields and climate in the Bethal, Ermelo, Kroonstad, and Lichtenburg districts 1921–38. By the author. Unpublished.
6. See C. R. van der MERWE. *Soil Groups and Sub-Groups in South Africa.* Govt. Printer. Pretoria. 1941.
7. F. X. LAUBSCHER. 'Hybrid maize production'. *F. in S.A.*, Vol. XXVII, Jan. 1952.
8. C. J. N. A. GORTER. 'Streak disease in maize'. *F. in S.A.*, Vol. XXVI, Nov. 1951.

WHEAT

9. W. J. PRETORIUS. *An economic study of the wheat industry in the Union.* Dept. Agric. and For. Bull., 141. Pretoria. 1935.
10. W. J. TALBOT. *Swartland and Sandveld.* O.U.P. Cape Town. 1947.
11. J. C. NEETHLING. *A comparative study of wheat farming in four sub-areas in the winter rainfall crop district of the Union of South Africa.* Dept. Agric. Bull., No. 227, Govt. Printer. Pretoria. 1944.
12. *Report of the Wheat Commission.* Govt. Printer. Pretoria. 1941.
13. J. T. R. SIM and P. W. VORSTER. *Milling and baking tests on South African wheat varieties.* Dept. Agric. Bull., No. 116. Govt. Printer. Pretoria. 1932.

10

Sugar Cane

Sugar cane is indigenous to the coastal belt of Natal where its luxuriant growth encouraged the early settlers to import cultivated varieties from established sugar producing countries[1] with the idea of starting commercial production. The first cuttings were imported in 1847 and planted near Umhlali[2] on the north coast. Two years later the first mill was erected and in 1851 the first raw brown sugar produced. Soon cane cultivation spread through the coastal belt north and south of Durban, being stimulated by easy terms of land acquisition and the imposition of a duty on imported sugar. By 1859 production exceeded 1,000 tons of which nearly 300 tons were exported. But further development was hampered by unrest in Zululand, inadequate transport facilities, poor milling facilities, and, most serious, difficulties in obtaining reliable labour, the local Bantu being unskilled in agriculture and disinclined to offer their services. The labour problem, however, was eased by the introduction of indentured Indians between 1860 and 1866. Thereafter the acreage under cane was rapidly extended and by 1878 sugar production exceeded 16,000 tons. The last quarter of the century, however, brought marketing difficulties, for Germany dumped surplus beet sugar at South African ports, Mauritius began to export at prices lower than that of Natal sugar, and the Transvaal republic, under a trade treaty concluded with the Portuguese Government, admitted Mozambique sugar duty free. Acreage expansion therefore ceased and attention was devoted to increasing yields through the use of improved varieties and better cultural methods.

After the Anglo-Boer War an agreement between the several colonies accorded the Natal sugar industry preferential treatment and protection against dumping by sugar producers with large surpluses. At first little increase in acreage occurred, but the use of improved varieties of cane and the adoption of better cultural practices led to increased production. Then in 1905 Zululand was opened for development, railways were extended, and, following Union in 1910, extensive new areas were brought under cane. The war gave a fillip to the industry and such was the expansion that by 1919 the sugar output exceeded 150,000 tons. In the following years generally high world prices and, compared with other countries, relatively low production costs, led to further extensions in the cane

acreage. By now South Africa was able not only to meet her own sugar requirements but to furnish a surplus for export; this exceeded 70,000 tons in 1925–6. The post-war boom, however, was now over, and increased cane production and the recovery of beet production in many countries led to a disastrous fall in world prices. Encouraged by increases in the import duty to £8 per ton in 1926, £12 10*s*. per ton in 1930 and £16 per ton in 1952 and despite the fixing of maximum prices of £22 per ton refined sugar and 3¾d. per lb. retail on the home market, the acreage under cane in Natal and Zululand continued to expand. Increasingly quantities of sugar had to be exported at world prices which continued to fall. By 1936, following the export of over 212,000 tons at less than £6 10*s*. per ton, the losses on exported sugar were so great that measures were enacted for limiting production on a quota basis. Next year, under the International Sugar Agreement, South Africa was given an export quota approximately equal to her output surplus to home needs. Production levelled at a little under 500,000 tons of sugar of which rather less than half was exported annually at rising world prices until the outbreak of war in 1939. Efforts were then made to increase production to meet the increasing demands on the home market occasioned by the expansion of the fruit preserving and confectionery industries and by the increasing sugar consumption of all sections of the population. During the war a yearly output approaching 600,000 tons was achieved. Drought curtailed the output of the 1946–7 and 1947–8 seasons but with the extension of cane cultivation to irrigable areas along the Pongola river, the output exceeded 720,000 tons in 1953–4 and will probably exceed 800,000 tons in the near future. This, however, is little more than home needs, and export has fallen to negligible proportions.

The main cane area occupies the belt of rolling to hilly country (Plate 37) extending from Port Shepstone in the south to Hluhluwe in the north (Fig. 65). Most plantations occur within 7 to 8 miles of the sea but some extend up to 20 miles inland. Although sugar cane is indigeneous to this region, the climatic conditions are near the margin for successful commercial production. Thus the mean annual temperature of 70° F. is only 2° F. above the lower limit for the crop, and the winter average of 60° F. is low. Fortunately, due to oceanic influences, the nights are warm and frost is practically unknown. The annual rainfall of around 40 inches is just adequate and its distribution is advantageous, the summer maximum encouraging vegetative growth and the well marked winter dry season favouring the concentration of sucrose and facilitating the harvest. The relative freedom from pests and diseases which the area enjoys is probably associated with the cool dry winter. Against these advantages, however, because of the marginal conditions the crop takes about two years to mature compared with 15 to 20 months in most cane growing countries.

Within this cane belt the soils vary according to their parent material. Those derived from basalt north of Empangeni and from the alluvium of the river flats are inherently most fertile and give the highest yields of cane; by contrast those

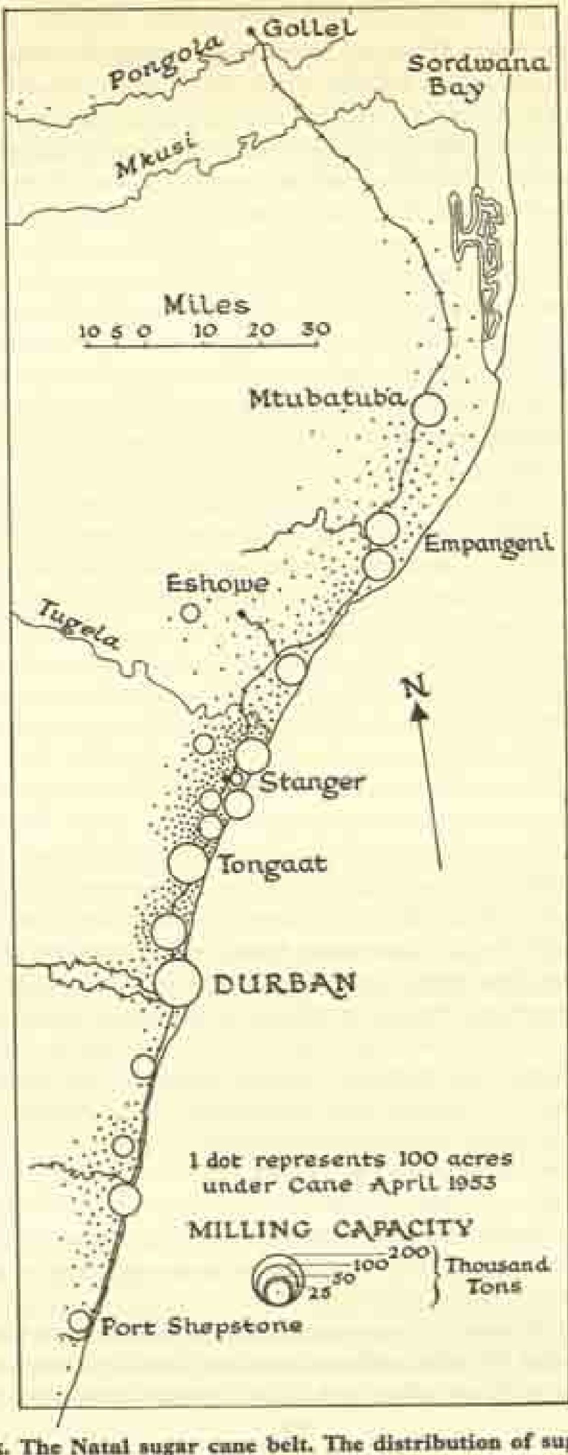


Fig. 65. The Natal sugar cane belt. The distribution of sugar cane production and of milling capacity.

weathered from granite between Umzinto and Umzimkulu, from Dwyka conglomerate between Durban and the Tugela river, from Table Mountain Sandstone towards the interior and from recent sands near the coast are poorest in plant nutrients; intermediate are those formed from Ecca shales and dolerite. All are generally well supplied with potash and are capable, with proper fertilization – notably with phosphate and nitrogenous compounds – and wise cultural practices, of yielding good cane crops. Legumes such as sunnhemp or velvet beans are sometimes grown as green manuring crops between successive plantings of cane in order to increase the organic matter in the soil, but with the present urge for greater production this rotation is often omitted. On many plantations work oxen and mules furnish much needed manure, while the cane trash and filter cake, a sugar refinery by-product rich in mineral nutrients, are generously used. Generally speaking the maintenance of soil fertility is less difficult with sugar cane than with most crops in South Africa.

Any extension of the present cane belt of Natal is unlikely for northwards the rainfall is inadequate, southwards the temperatures are too low and inland the country is too hilly. The best opportunities for increasing the cane acreage occur along the Pongola river and in the coastal plain between the Pongola and Mkusi rivers where irrigation projects are under way (see ch. 7, p. 141). Already a mill has been erected at Gollel. The acreage available here, however, necessarily limited to the irrigable land, is relatively small. Increased production of sugar will thus have to come mainly from the use of better varieties of cane and from higher yields per acre.

Prior to 1935 most of the sugar cane grown in South Africa was of the Uba variety, bred from an unidentified imported cane in the 1880's. Although difficult to mill and with a somewhat low sucrose content, it maintained its superiority owing to its resistance to mosaic disease. Eventually, however, it became infected with streak disease. Meanwhile the successful introduction of improved hybrid types in India (the Co, i.e. Coimbatore types), and in Java (the P.O.J., i.e. the Proefstation Oost Java types), prompted their trial in Natal. At the same time at the Sugar Experimental Station, established by the Sugar Association at Mount Edgecombe in 1927, the breeding of new hybrids from the seed of Coimbatore cane grown in Natal was undertaken. This has resulted in the evolution of a new variety known as N.Co 310 (i.e. Natal Coimbatore 310) giving higher yields than any other cane in Natal. The supersession of the Uba cane by the new varieties (Table 3) has been accompanied by a marked increase in yield. Today yields of over 3 tons of sugar per acre are obtained, which compare favourably with the yield of all other sugar-producing countries except Hawaii and Java, the cool dry winter resulting in a higher sucrose content in the cane than in most tropical countries.

Sugar cane is grown by between seven hundred and eight hundred European planters and by some eighteen hundred Non-European producers. In addition fifteen mills also plant cane. The European producers, however, are

Table 3. Cane Varieties. Percentage of Acreage under Each Variety 1935–52

	Uba	*Co281*	*Co290*	*Co301*	*Co331*	*N.Co310*
1935	92		8			
1936	64	2	24			
1939	30	28	30	3		
1942	11	52	19	11		
1945	3	68	4	21	0·6	
1948						
1952	0·13	11	2	32	16	38

responsible for 85 per cent of the output; of these 70 per cent have an output of 5,000 tons or less and together account for only 23 per cent of the total production while less than 5 per cent account for nearly 40 per cent of the crop. The industry is thus very largely in the hands of big estate owners.

The cane is planted after the first good summer rains, usually from September to November, and harvested two years later during the period May to December. For both these operations much labour, which today is difficult to obtain, is required. Altogether about 1,100 Europeans and nearly 56,000 Non-Europeans work in the canefields. Few Indians are employed today, most of the descendants of the original immigrants now being engaged in farming or commerce on their own account, while the industry attracts only the less fit Africans, those of strong physique preferring work on the mines. Hitherto planting and harvesting have been carried out by hand, the hilly nature of the country making mechanization difficult, but the acute labour problem led the South African Sugar Association to set up in 1948 an Agricultural Mechanization Committee to promote the invention of planting, cultivating, cutting, loading and transport machines suitable for the hilly terrain. Already successful planting machines have been developed and progress made towards the construction of harvesting machines. The large estates are served by light railways. On these the traction may be furnished by steam or diesel engines or by mule teams. In some cases the cane is conveyed direct to the mills, in others it is taken to the nearest railhead for transport by South African Railways to the mills.

In the early days practically every planter had his own rather primitive mill. In 1859 there were seventeen such mills producing a little over 1,300 tons of sugar. By 1868 the number had increased to fifty-seven and the output to 10,000 tons and by 1879 to seventy-nine with an output of nearly 17,000 tons. Thereafter, however, the number of mills declined, the factory capacity was increased in the more central and most favoured locations and the planters sold their cane to the nearest mill. By 1937 there were only twenty-three mills and by 1953 only seventeen (Fig. 65). Refining is effected at the large central refinery in Durban and at smaller refineries attached to the mills at Mount Edgecombe and Illovo. At the last mentioned golden syrup is also produced. Of the by-products of the industry the bagasse – the exhausted cane fibre – is used as fuel in the mills, the

filter cake is distributed among the growers and the molasses is sold to the chemical industries.

The sugar industry, developed very largely under the cloak of Government protection, has been characterized by close co-operation between growers and millers and by the free exchange of ideas between all its members. This has enabled it to achieve a high degree of organization, support research establishments and attain a high level of productivity. At the same time the fixing of ceiling prices for refined sugar by the Government has assured the consumer relatively low and stable sugar prices in contrast to the position in Australia and the beet-sugar producing countries of Europe.

BIBLIOGRAPHY

1. Union of South Africa, Board of Trade and Industries Report, No. 298. 'The South African Sugar Industry Review'. Govt. Printer. Pretoria. 1947.
2. South African Sugar Yearbooks.

11

Other Crops

The relative importance of the other crops grown in South Africa may be gauged from the following table. These crops may be considered in five categories: tobacco; fibre crops; potatoes, vegetables and flowers; groundnuts and other oil-bearing plants; and grasses, hay and fodder crops and rotation legumes.

Table 4. Union of South Africa. Acreage and Production of Other Crops 1953–4

	Area Planted or Sown (thousand morgen)	*Area Reaped (thousand morgen)*	*Production (million lb.)*
Turkish Tobacco	0·7		
Other Tobacco	25·9		
Cotton	21·1		24·4
Potatoes	54·5	53·4	496·3
Onions	4·7	4·6	73·7
Other Vegetables*	47·0		
Chicory*	8·5		
Groundnuts	231·5	225·2	348·0
Sunflower	115·3	110·2	89·9
Field Beans	102·5	96·3	79·4
Field Peas	5·6	5·1	9·0
Cowpeas	65·6	12·9	8·1
Lucerne	201·3		1,191·1 (hay)
Teff*	145·7		571·1 (hay)
Other Cultivated Grasses	65·4		

* 1949–50 Census.

Tobacco

Tobacco was one of the crops grown by the first Dutch settlers in the south-western Cape. Later its cultivation spread to other parts of South Africa, notably the Oudtshoorn, Magaliesberg, and Piet Retief districts. Until the present century most growers used all their leaf for the manufacture, on the farm, of roll tobacco by a simple process of fermentation. This so-called 'Boer' tobacco was

used for smoking, chewing, and snuff. With the growth of cigarette smoking during the present century, however, the old market has been largely lost, and the growers have had to change over from the dark and heavy leaf to lighter types and from air-cured to flue-cured tobacco in order to meet the needs of the cigarette manufacturers. Some production of heavy leaf has continued, however, to supply the lucrative market for snuff and pipe tobacco among the Bantu.

The aroma, character and quality of tobacco leaf depends very largely on the climatic and soil conditions under which it is produced. In South Africa tobacco is grown in both the summer and winter rainfall areas (Fig. 66) and in a variety of different soils. In consequence striking variations occur in the type of leaf grown in the different localities. Both Turkish and Virginian types are grown.

South Africa and the Rhodesias are the only producers of Turkish tobacco outside the Near East. In the Union it is grown only in the Western Province. Here the first experiments were made only in 1904 in the Franschhoek district[1] but they proved so successful that the acreage expanded rapidly and the crop for the 1911–12 season exceeded ¼ million lb. The industry was then organized on a co-operative basis. This encouraged further production with the result that by 1931 the farmers were faced with a surplus they could not sell. Since then the acreage has been controlled. The growers have enjoyed good markets, however, during and since the second world war and in recent years the production has averaged over 1 million lb.

In the south-western Cape the production of Turkish tobacco is favoured by highly suitable climatic and soil conditions. Since there is little danger of frost early maturing varieties may be grown and expensive cheesecloth protection for the seedbeds may be dispensed with. The winter rainfall provides the necessary soil moisture before planting time and the less frequent showers of spring are adequate for the normal development of the plants. The drier sunnier days of early summer promote the maturing of the leaves and facilitate the subsequent sun-curing process by which Turkish tobacco has to be prepared. With early maturing varieties all the leaves are harvested by January and since the curing takes only two to three weeks under the hot dry conditions, the handling of the crop is completed before the start of the busy wine pressing season. Labour requirements indeed dovetail with those of other crops so that tobacco fits well into the agricultural economy.

The main producing areas are dictated very largely by the soil conditions. Sandy loams favourable for the production of high quality leaf occur over the granite outcrops in the Helderberg–Stellenbosch–Elsenberg area and over the Malmesbury beds around Wellington, Riebeeck Kasteel, Riebeeck West, and Tulbagh;[2] these are the main producing areas. In some years when market prospects are good the acreage extends on to red loams and red clay loams derived from an admixture of granite and shale of Table Mountain Sandstone age but unless the season is dry the leaf tends to be dark and coarse.

The Turkish tobacco areas of the Cape enjoy a relative freedom from pests

and diseases. Frequent winter ploughing is necessary, however, to keep down cut-worms and regular spraying essential to prevent the outbreak of 'wild fire' disease. Eelworm has not been serious but it may become so on the sandier types of soil where the recent extension of tobacco growing has taken place.

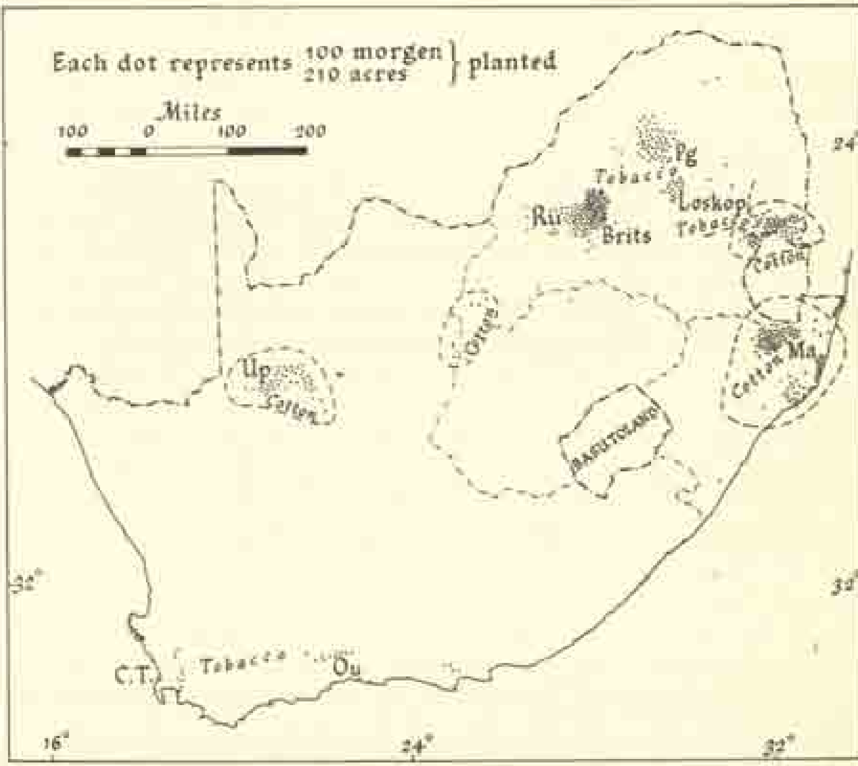


Fig. 66. The distribution of tobacco and cotton cultivation.
(1953/4 census.)

Of the tobacco produced in South Africa today, however, 97 per cent is of Virginia type. It is grown in the irrigable valleys of the Transvaal Bushveld and Lowveld and the Cape Folded Belt and in the Vredefort, Potchefstroom, and Klerksdorp areas along the Vaal river. Production has increased enormously since 1930 (Table 5) with the completion of a number of Government irrigation projects (ch. 7, p. 138) and the greatly expanded market particularly since the second world war. The expansion has been marked by the growth of tobacco co-operative organizations and has been aided by the work of the Government research station at Rustenburg and experimental farm at Hartebeestpoort.

The environmental conditions in the Transvaal Bushveld are not particularly favourable for light cigarette tobaccos. The great difference between the day and

Table 5. Union of South Africa. Tobacco Production 1930–1 to 1950–1

<table>
<tr><th rowspan="2">Year</th><th rowspan="2">Turkish (million lb.)</th><th rowspan="2">Flue-cured (million lb.)</th><th colspan="2">Air-cured</th><th rowspan="2">Total (million lb.)</th></tr>
<tr><th>Light (million lb.)</th><th>Dark (million lb.)</th></tr>
<tr><td>1930–1</td><td>1·6</td><td>0·08</td><td colspan="2">20·0</td><td>21·7</td></tr>
<tr><td>1938–9</td><td>0·8</td><td>5·4</td><td colspan="2">17·6</td><td>23·9</td></tr>
<tr><td>1950–1</td><td>1·3</td><td>22·0</td><td>12·0</td><td>17·9</td><td>53·3</td></tr>
</table>

night temperatures is not conducive to the production of high quality leaf and the soils, particularly those derived from norite, are generally too heavy. The low and unreliable rainfall makes irrigation essential, thereby increasing the expenses of cultivation, and considerable losses may result from summer hail. That tobacco growing has increased in face of these difficulties is due largely to the fact that it affords the most suitable cash crop for farmers with little capital and only a limited amount of land on the Government irrigation settlements.

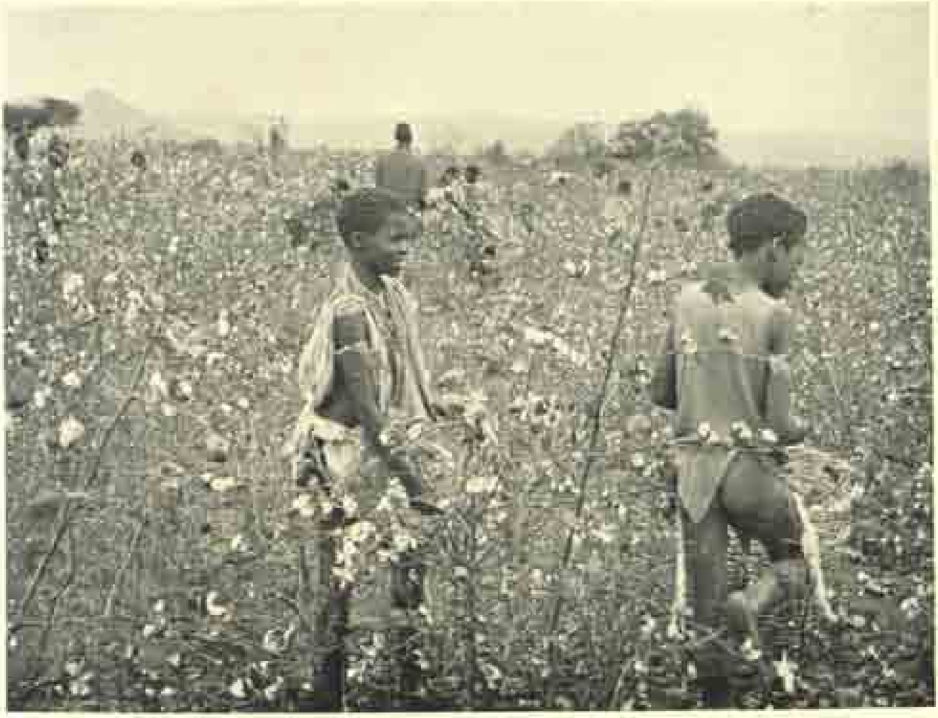
Formerly nearly all the Virginia type tobacco was air-cured but during the past twenty years there has been a great increase in flue-curing and today nearly half the crop is prepared in this way. Whereas before 1939 the Union growers did not produce the quantity of flue-cured tobacco required by local cigarette manufacturers, the deficiency being met from Rhodesian sources, today there is an exportable surplus. At first difficulties were experienced in selling this surplus for only the Amarelo variety was grown, whereas overseas consumers preferred Orinoco. Since 1950, however, with the fixing of the price for the latter variety at 33 per cent above that for Amarelo, there has been a change over to Orinoco tobacco production. A large part of the tobacco grown in the Transvaal, however, is dark leaf and air-cured. This finds its way mainly into the pipe tobacco and snuff markets.

In the irrigated valleys of the southern and south-eastern Cape Joiner and Groot Swazie tobacco varieties are grown for pipe and snuff purposes. Some light air-cured and flue-cured Amarelo and Orinoco tobaccos are grown near Oudtshoorn for cigarettes (Plate 41). Most of the tobacco produced in the Transvaal Lowveld is for snuff.

Fibre Crops

The only fibre crop grown on any scale in South Africa is cotton, which has occupied a small but steadily increasing acreage since the second world war.

The climatic conditions in the Bushveld and the Lowveld and in northern Natal and Zululand are on the whole suitable for cotton. Frost is rare and the temperatures are sufficiently high during the growing season to promote excellent development of the plant. The annual rainfall generally exceeds 20 inches and cotton is better able to withstand the irregular dry spells of summer than most other plants. Hitherto its production has been hampered mainly by the ravages



40. Swazi children picking cotton near Balegane, Swaziland. In Southern Africa successful cotton production depends on cheap labour. Mechanical cotton pickers are unknown.

41. Tobacco grown under irrigation near Oudtshoorn in the Little Karoo. Here it is the main cash crop. The mountains in the distance are a minor range south of the Swartbergen.

42. Orchards of apple trees (in blossom) on the lower slopes and of peach trees (in leaf) on the hilltops of the Elgin Basin. The steep kloofs are left in natural veld (centre). Note the windbreak of eucalyptus trees on the right. In the distance the Groenland mountains rising abruptly from the basin.

43. Irrigating young peach trees by means of an overhead sprinkler in the Elgin Basin. Note the cover crop grown to reduce erosion and to provide green manure, and the windbreak of conifers.

of insect pests – jassid, stainer and bollworm – and by low world prices. Cotton breeding work at the Barberton Experimental station, which was originally established by the Empire Cotton Growing Corporation but has now been taken over by the Union Government, has evolved jassid resistant varieties but stainer and bollworm remain problems. Moreover, much depends on market prices. Because of low yields, consequent on insect attack and recurrent drought, and shortages of labour, production costs are higher than in Uganda and the cotton-producing countries outside Africa. Before the war, when growers were dependant on overseas buyers cotton did not pay. During the boom period after the first world war large acreages were put under cotton near Rustenburg, Barberton, and Magut, but with the fall in world prices after 1925 the crop was given up. Since the second world war the development of a Union textile industry (see ch. 28) has created a home market and the crop has been taken up again in the same areas as previously and also along the Orange river where fine quality cotton is grown under irrigation. The cotton is dealt with at ginneries at Barberton, Upington, and Magut. In 1952 nearly 30,000 bales (of 500 lb.) of cotton lint were produced. This was barely half the requirements of the Union factories. Since then the acereage has increased, but the yield has fluctuated. European farmers in Swaziland have also taken up the crop but the production is small.

Since 1945 a new fibre crop known as 'Stokroos' (*Hibiscus cannabinus*) has been grown on a small scale in the Lowveld and Bushveld for use as a substitute for jute in bag manufacture. Because of the world shortage of jute and the strained relations between the Union and India its cultivation has received official encouragement. Decorticating machinery and retting tanks have been erected at Nelspruit and Groblersdal but the acreage under the crop remains small.

Although the agave which yields sisal grows well in the Bushveld and Lowveld and is widely used as a 'hedge' in the Native territories, there are no commercial plantations to compete with those of East Africa, partly because world prices are comparatively low and partly because the South African Bantu dislike handling the crop.

Thus generally speaking although climatic conditions are favourable fibre crops are not important in South Africa, largely because there is not the labour to handle them and with their low world prices they simply do not pay. Under South African conditions other enterprises are more profitable.

Potatoes, Vegetables, and Flowers

The potato ranks as one of the leading crops of the Union of South Africa. It is grown in most parts of the country but large scale commercial production is confined to one or two areas in which the climate and soil conditions are particularly favourable (Fig. 67). The main crop is a summer one but potatoes are also grown on an appreciable scale as a winter crop in the Transvaal Lowveld and

in the warmer parts of Natal and the Cape province. In most years the summer crop comprises about 3½ million bags of 150 lb. and the winter crop about ½ million bags. The area of light sandy soils on the Highveld between Bethal and the Witwatersrand accounts for about two-thirds of the summer crop and the Transvaal Lowveld for two-fifths of the winter crop. In the latter region the potatoes are grown under irrigation, the higher and cooler valleys west and north of

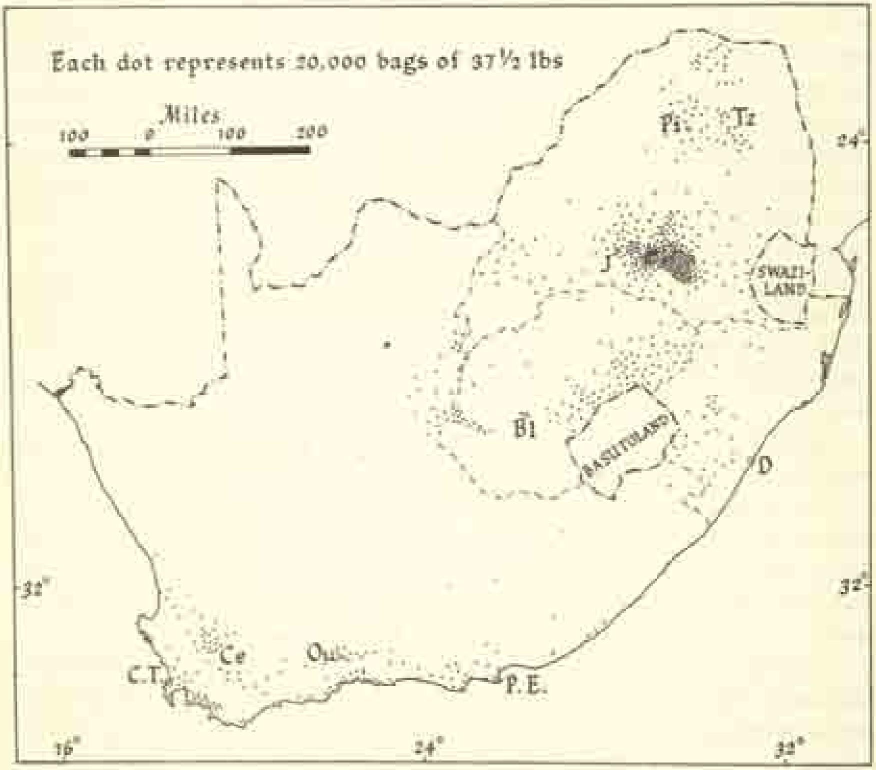


Fig. 67. The distribution of potato production.
(1953–4 census.)

Tzaneen being the most important centres of production. In the Orange Free State potatoes are grown mainly in the eastern districts extending from Thaba Nchu and Ladybrand to Harrismith where the summers are relatively cool and the light sandy soils favourable. The production of seed potatoes is a speciality on the Riet river irrigation settlement where the arid conditions are associated with an absence of diseases or pests. On the Vaal-Hartz irrigation scheme, however, root eelworm is a serious problem. In the Cape the main producing areas are in the southern coastal belt where sufficient rainfall is received during the summer months for potatoes to be grown without irrigation, and where the

comparatively cool days are favourable; here, too, the rather light sandy soils are eminently suitable.

In most years the South African potato production is more than sufficient for home needs and about 30 million lb. are exported mainly to the more tropical African territories, particularly Portuguese East Africa, Mauritius, the Belgian Congo and the Rhodesias; shipments are sent also to Singapore and South America where high temperatures limit potato production.

The main purpose of the first European settlement on Table Bay in 1652 was the production of fruit and vegetables for the Dutch merchantmen passing between Europe and the East. Since then with favourable environmental conditions and a continually expanding market vegetable production has steadily increased in the south-western Cape while it has become important in other parts of the country with the growth of the urban population following the development of mining and manufacturing. During the second world war the ancient function of Cape Town as a provisioning station was revived and large quantities of vegetables as well as fruits were required for the ships carrying troops to African and Asian theatres of war. At the same time the needs of the armed forces in North Africa had to be met. Vegetable production expanded very greatly and a large canning and dehydrating industry developed. Since the war vegetable production has continued to increase in order to meet the demands of the growing urban centres for fresh produce and to supply the canneries which have a growing export both to African and to overseas territories.

A great variety of vegetables are grown in South Africa and the great range of climatic conditions between one region and another ensure the availability of all kinds on the main urban markets at all seasons of the year. With the exception of certain areas in the south-western Cape, on the Transvaal Highveld and in Natal vegetables are everywhere grown under irrigation. The Transvaal Lowveld is an outstanding producing region (see Fig. 68) which, being relatively frost-free, caters largely for the winter market. The main crops are tomatoes, cabbages, green beans and peas, which are marketed throughout the Union. In the Transvaal Bushveld, where vegetable production is important on the Loskop and Rust-der-Winter irrigation schemes and in the Warmbaths area, conditions are slightly cooler and the main emphasis is on early summer crops of watermelons, pumpkins, squashes, and marrows. On the Highveld where the producing areas are confined to the valleys of the headstreams of the Vaal and Olifants rivers, vegetable production is confined to the summer months. Tomatoes, pumpkins and squashes are the leading varieties, but near Johannesburg and Pretoria mixed vegetables are produced by a number of Portuguese market gardeners.

In the western Cape the main vegetable producing areas are on the Cape Flats around Vredendal and Klawer, and in the irrigable areas in the Paarl, Stellenbosch, Worcester, and Robertson districts. The first mentioned area produces a great variety of vegetables for the Cape Town market while the latter

district concentrates on peas, beans, and tomatoes for the canneries at Daljosaphat and Ashton. The light soils of the Caledon coastal belt are famous for the production of onions and garlic. In the eastern Cape the relatively cool Gamtoos valley concentrates on cauliflowers and cabbages, the Langkloof and Oudtshoorn areas on onions. The George district in the southern Cape produces numerous different varieties.

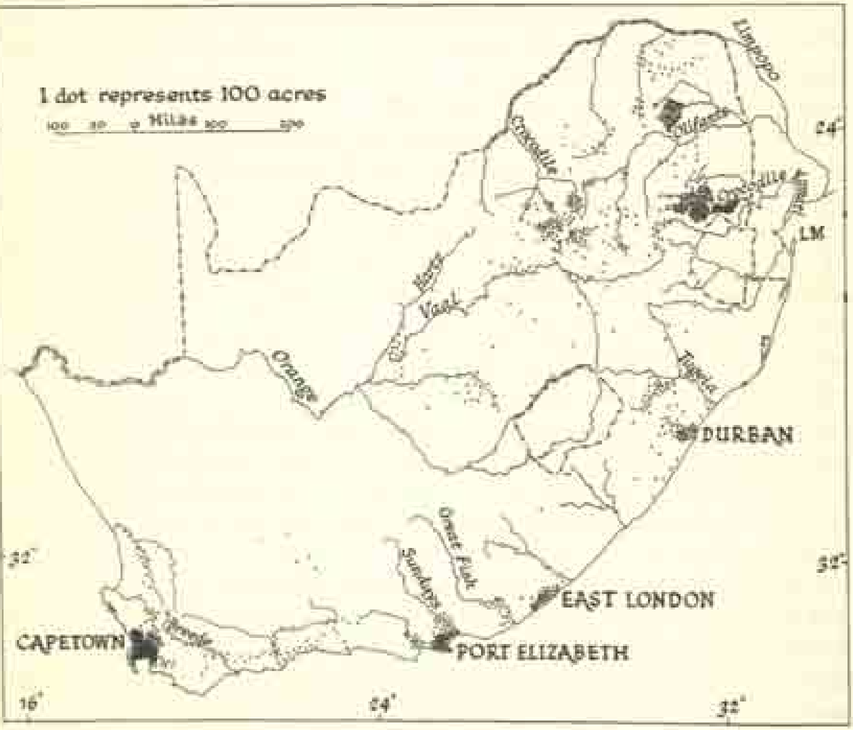


Fig. 68. The distribution of vegetable production.
(1949–50 census.)

The valleys of the Riet and Modder rivers, the Caledon river lands and the area around Bloemfontein produce most of the vegetables grown in the Orange Free State. Pumpkins, watermelons, beans, and peas grown chiefly for the Bloemfontein market are the main crops.

Due to the differences of climate between the coast and the interior, Natal is able to produce a great variety of different vegetables. In the warmer coastal areas, peppers, chillies, and bringals (egg plant) are important; pumpkins, squashes, carrots, sweet potatoes, tomatoes, leeks and beetroot are grown everywhere, being grown in winter in the warmer localities and in summer elsewhere. The most important producing areas are in the Mooi river valley, around Grey-

town, and near the main road and railway zone between Estcourt and Durban. A large part of the production comes from small Indian market gardens, located mainly in the river valleys.

The growing of flowers for the cut-flower trade is largely confined to the vicinities of the big cities. In the Transvaal Lowveld, however, large quantities of gladioli, carnations, and larkspur are grown in winter for the distant Johannesburg market. In the Cape, the Cape Coloured people and the Malays gather wild heaths, proteas, and chincherinchees from the mountain slopes. These wild flowers are sold mainly in Cape Town but there is a small export by air to the United Kingdom.

Groundnuts and Other Oil-bearing Plants

Today the acreage under groundnuts is fourth after that of maize, wheat, and oats and exceeds that of Kaffir corn among the arable crops grown in the Union of South Africa. The crop has been grown for many years on the Springbok Flats (see ch. 44, p. 646) but has become really important only since 1939 largely in response to the increased consumption of edible fats and oils concomitant with the movement of the population from rural to urban areas and to the price encouragement held out since 1942 to stimulate production. Since the pre-war years the production has increased more than tenfold, in 1951–2 the acreage exceeding 230,000 morgen (nearly ½ million acres) and the production nearly 3½ million bags (of 100 lb.), of nuts (156,000 tons). The bulk of the crop goes to the factories for oil expressing and margarine manufacture but the high-quality nuts enter the confectionery and edible nut trades, some being used at home and the rest exported.

Groundnuts are relatively drought-resistant and grow well in those areas where rather low and uncertain summer rains make maize somewhat precarious. Sandy soils which are easy to cultivate and from which the nuts are readily lifted are most suitable. They therefore do well in those areas less favourable for maize. The main areas of production (Fig. 69) are the Springbok Flats, and the areas of sandy soil in the drier parts of the western Transvaal and north-western Orange Free State where the crop fits well into the farming economy. Groundnuts are important also on the Vaal–Hartz irrigation scheme where high quality nuts for roasting and salting are produced. Everywhere the crop is grown on an extensive scale by highly mechanized methods. The vine yields a nutritious hay while the cake left after expressing the oil forms a palatable high protein concentrate for cattle. Groundnuts, therefore, not only furnish a valuable cash crop for rotation with maize, but occupy an important place in the mixed farming economy.

Only sunflowers among other oil-bearing plants are important. They are grown only on the Highveld where they enter the rotation of maize and other crops. Efforts have been made to encourage the cultivation of soya beans which, in addition to their oil content, yield a high quality protein meal valued for the

enrichment of the diet of mine labourers, and furnish protein rich hay for stock feed. The tendency of the crop to shatter during the hot dry weather at the end of the Highveld summer, however, discourages its cultivation and although new varieties bred at the Potchefstroom and Pietermaritzburg agricultural research stations are now available and price inducements are held out to farmers the acreage remains small.

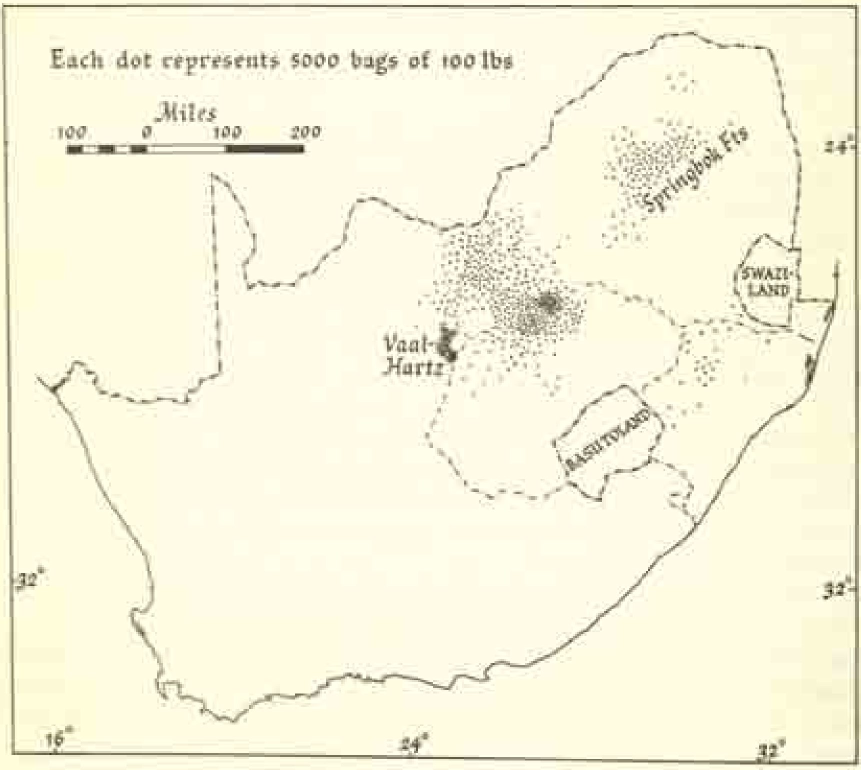


Fig. 69. The distribution of groundnut production.
(1953–4 agricultural census.)

Grasses, Hay and Fodder Crops, and Rotation Legumes

The establishment of long and short ley pastures, the growing of hay and fodder crops, and the use of rotation legumes are recent developments in South Africa and as yet the acreage devoted to them is restricted.

Because of the very different climatic conditions different types of grasses succeed in the winter and summer rainfall areas respectively. The paucity of grasses in the natural vegetation has necessitated a dependence on exotic grasses in the winter rainfall area; but paradoxically because seed has been readily available from other countries the establishment of grass leys progressed at an

earlier date than in the summer rainfall area where grasses abound in the natural vegetation. Seed from indigenous grasses, however, is now available for the summer rainfall area and in all the better watered parts of the country the establishment of good pasture is progressing.

Outstanding among the hay crops are lucerne and teff (*Eragrostis tef* (Zucc) Trotter). The former is grown in the winter rainfall area and on irrigation

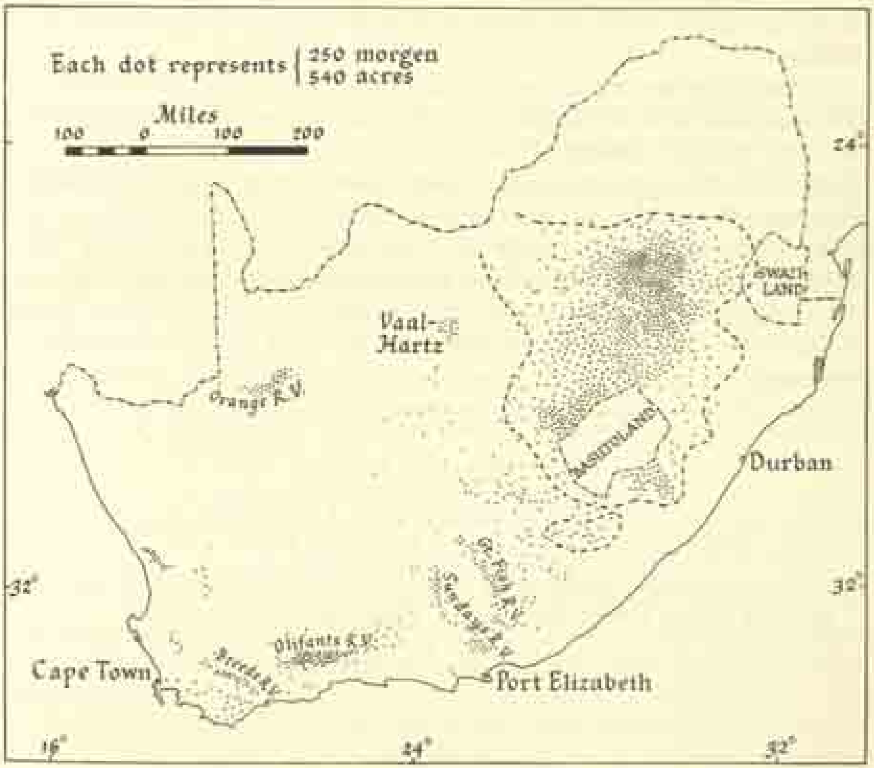


Fig. 70. The distribution of lucerne and teff cultivation.
(1953–4 census.)
(Teff is grown within the areas enclosed by the broken lines, lucerne elsewhere.)

schemes in the arid interior; the latter is grown in the summer rainfall area (Fig. 70). Lucerne first became important as a feedstuff for ostriches during the heyday of the feather industry. Today it is extensively grown on all the large government irrigation schemes in the Cape and the Orange Free State, in the Oudtshoorn district of the Little Karoo and also in small fields irrigated from wind pumps throughout the Great and Upper Karoo. Lucerne is an excellent rotation crop for the winter rainfall area and during the past twenty years, with the encouragement of a Government subsidy, has been grown to an increasing

extent under dryland conditions in rotation with wheat in the Swartland and the Rûens. Throughout the Cape lucerne is the mainstay of the dairying industry providing nutritious grazing as well as hay and silage for high yielding milch cows. The quick-growing summer annual teff has a similar place in the rotation and in the economy of the summer rainfall area. It is grown mainly on the eastern Highveld and in the Natal Midlands where the rainfall is sufficient to promote growth. Being drought-evading rather than drought-resistant it is not successful in the drier areas; neither is it grown in the high rainfall area where it is subject to lodging.

Most important among the rotation legumes are various kinds of beans and cowpeas. Beans grow well in most parts of the country and there is a large market for dried beans for feeding African mine workers on the gold mines. Speckled varieties are grown mainly for the Native trade, haricot and kidney beans for European consumption. Recently there has been some export of the haricot and kidney types. Soya beans (see pp. 197–8) are grown to a limited extent on the Highveld, mung, velvet, and dolichos beans in the Lowveld and Bushveld; cowpeas, being fairly drought-resistant, are the most widely grown annual legume in the Union. All these crops provide useful stockfeed and are valuable as soil renovators.

BIBLIOGRAPHY

1. H. L. STRYDOM. *Production of Turkish Tobacco in the Western Cape Province.* Union of S.A. Dept. Agric. Bull., No. 244, 1944.
2. J. L. STEENKAMP. *Survey of the most important Tobacco Soils of the Union of South Africa.* Union of S.A. Dept. Agric. Bull., No. 213, 1940.

12

Fruit

The important place occupied by fruit growing in the economy of South Africa may be gauged from its contribution to the export trade. In the pre-war period 1935–9 the value of fruit and wine exported averaged £3 million annually, second only to wool among the agricultural products. During the war little fruit was exported but after 1945 the export trade in dessert fruits and wine was quickly regained and with an increasing export of canned fruits and jams the total value of all fruit and fruit products exported has exceeded £15 million in recent years. The average annual gross value of the fruit crop is more than £25 million.

The Growth of the Fruit Industry

Fruit growing began soon after the first European settlement on Table Bay, one of whose main purposes, it will be recalled, was to supply fresh fruits, particularly citrus varieties, to ships passing between Europe and the East Indies. To fulfil this purpose a great variety of temperate and sub-tropical fruits were imported from Europe and the East and planted in the 'garden' of the Dutch East India Company.[1]

At first most attention was devoted to citrus fruit production, but with the occupation of the valleys of the south-western Cape by 'Free Burghers' interest centred increasingly on viticulture and wine making, for under the Mediterranean climate, the vine flourished where other crops failed, and wine was better able to bear the delays and difficulties of transport than most other commodities. Viticulture and wine making were actively encouraged by the Governors Simon and Willem Adriaan van der Stel[2] who imported winestocks from Europe and established model farms, Groot Constantia at Wynberg and Vergelegen at Somerset West respectively. Both activities received a considerable impetus from the settlement of Huguenot refugees from the Languedoc among the Dutch Burghers in the Great Berg valley. But they laboured under a number of difficulties. What little knowledge the early Dutch settlers had of viticulture had been gleaned from the wine producing areas adjacent to their homeland, i.e. the Rhineland and northern France, where relatively low temperatures necessitate a close

spacing of the vines. They naturally adopted this practice in the Cape with the result that in the hot dry summers the vines suffered from drought, defoliation and sunscald. The lack of wood suitable for casks and vats meant that these had to be imported, at high cost, from Europe and their consequent shortage compelled the farmers to sell their wine before it had had time to mature in order to make way for the next vintage. The wine was thus of inferior quality. Moreover its quality deteriorated during the long voyage to Europe, particularly when carried in ships' vats which had previously held arrack, beer, meat or bacon, and it soon acquired a poor reputation.

During the nineteenth century viticulture received some stimulus from the British Government's imposition of heavy duties on French wines and the granting of preference for the South African product. In 1859 the export exceeded one million gallons but when the duties on French wines were lifted two years later, it fell to a negligible amount. Soon after, in 1886, phylloxera ravaged the vineyards. A new start, however, was then made with resistant American rootstocks and, aided by the completion of a number of irrigation schemes, the acreage expanded rapidly. When, however, following the collapse of the feather market, just before the first world war, the ostrich farmers turned to viticulture, overproduction became serious; for the home market was extremely small and the product could not compete with that of France or Italy in the British market. By 1924 prices had dropped to such a low level that the K.W.V. (Ko-operatiewe Wynboers Vereeniging Van Suid Afrika) founded as a voluntary organization of wine producers in 1917, was given complete control over all wine distilling. At once it set about the task of improving the quality of South African wines and building up an export in good quality wines and brandies. In the attainment of these objectives it was aided by the new uses of concrete for vats and by Empire Preference. At the same time the opportunities for the export of table grapes provided an alternative outlet for the wine grower and led to a considerable extension of the acreage under vineyards.

Meanwhile apart from the small supply of fruit to passing ships, deciduous and citrus fruits were grown only for home needs. Individual orange and naartje trees were planted in the eastern Cape at the beginning of the nineteenth century[3] and subsequently the voortrekkers raised seedling orange trees in the western Transvaal and planted the Transvaal yellow peach, descended from stock imported from St Helena, wherever they settled, but the total number of trees was small and no commercial orchards were established.

It was not until after the opening of the Witwatersrand goldfields that the commercial production of fresh fruits became important. Then the attraction of the nearby urban market encouraged the planting of large numbers of trees, particularly peach, on irrigable land in the southern Transvaal and northern Free State. The completion of the trunk railways, by bringing the Cape within range of the Transvaal market, encouraged the Cape farmers to follow suit particularly after phylloxera had devastated their vineyards. In the Cape fruit growing was

further encouraged when, in 1895, trained horticulturalists, mainly from California, were brought in to develop the industry. The favourable reception accorded South African fruit at the Royal Horticultural Society Show in London in 1906 provided a further stimulus and with the negotiation of favourable sea rates with the Union Castle Shipping Company in 1912 and the extension of railways and refrigeration, the way was prepared for the development of an export trade. The 1914–18 war delayed this but after 1918 high prices on overseas markets encouraged large plantings of both deciduous and citrus fruits and the export trade expanded rapidly (Figs. 71 and 72), so rapidly indeed that Cape Town was unable to handle all the fruit expeditiously and much of it arrived in England in poor condition. These marketing difficulties led to the establishment in 1922 of the Fruit Growers Co-operative Exchange incorporating growers of deciduous and citrus fruits and pineapples, in order to facilitate shipment. In 1926 this organization split into two independent organizations, namely the Deciduous Fruit Exchange and the Citrus Fruit Exchange. In the same year new pre-cooling facilities were completed at Cape Town docks. Thereafter exports increased steadily to a maximum in 1937–8 when over 237,000 shipping tons of citrus fruits and over 90,000 tons of deciduous fruits were sent overseas, mainly to the United Kingdom. The outbreak of war in 1939 cut off this market and the difficulties experienced by the growers in the disposal of their fruit led the Government to set up the Deciduous and Citrus Fruit Boards charged with the control and disposal of all fruit. Increasing quantities were dried while the canning and jam-making industries expanded fourfold. At the cessation of hostilities the United Kingdom market was reopened and the export of both citrus and deciduous fruits soon equalled and exceeded pre-war figures. After 1945 this expanding export market together with the growing demands for fruits of all kinds from local canners and jam manufacturers encouraged extensive new plantings, particularly of peach and apricot trees in the south-western Cape and of orange trees in the Transvaal. Between 1946 and 1950 the number of citrus trees rose from 4½ to 5 million, that of peach from 4½ to 5½ million and that of apricot from 1½ to 2¾ million. Smaller plantings of other fruits were also made. Further planting is continuing with a general tendency as far as deciduous fruits are concerned to favour canning rather than dessert varieties.

Before 1939 sub-tropical fruits other than citrus varieties were grown on a small scale in favourable localities mainly to supply the home market. Only pineapples were exported in any quantity. After 1939, with malaria effectively controlled, settlement became possible in the warmer parts of the country, notably the Lowveld, which hitherto had been unhealthy. Here large plantings of tropical and sub-tropical fruits have been made since 1945.

Thus today South Africa is an important producer and exporter of a great variety of temperate and tropical fruits. Of these, deciduous tree fruits and grapes are grown mainly in the south-western and southern Cape and citrus and other sub-tropical and tropical fruits in the eastern part of the country.

Deciduous Fruits

By far the most important deciduous fruit-producing region is the south-western Cape. Here the Mediterranean climate is generally favourable provided the trees can be irrigated during the dry summers. In practice this means that fruit growing is almost entirely limited to the valleys and intermontane basins where

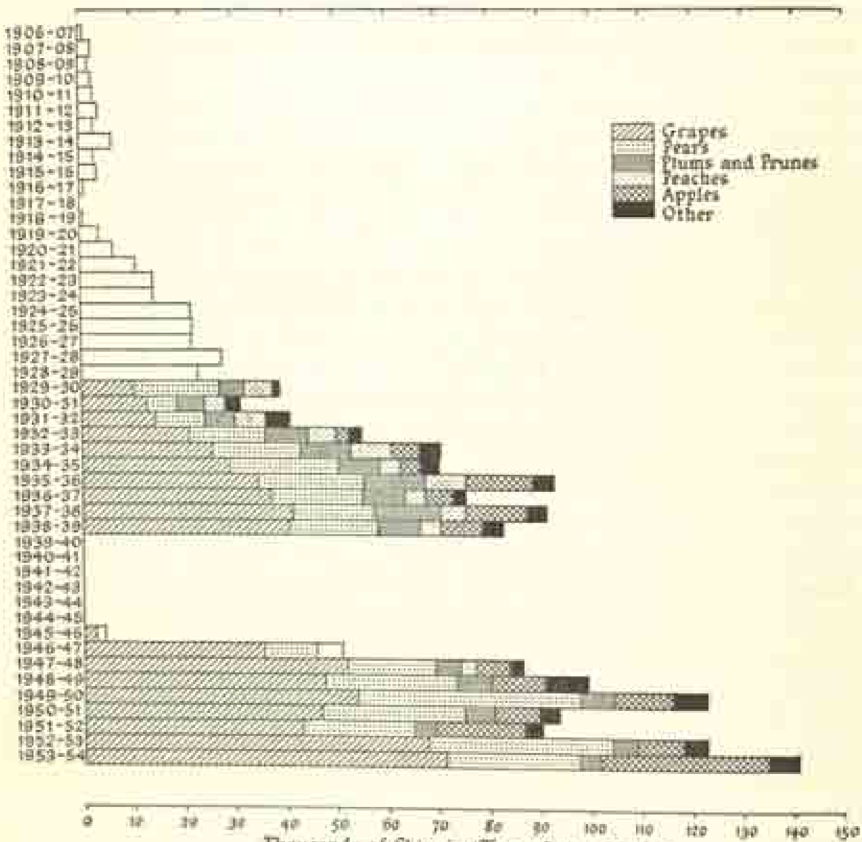


Fig. 71. Yearly exports of deciduous fruits from the Union of South Africa 1906–54.

(Note statistics regarding the variety of fruit exported before 1929 are not available.)

perennial streams, fed by fresh waters issuing from the Table Mountain Sandstone at the foot of the fold mountains, provide opportunities for irrigation.

In these mountains and valleys the temperatures are on the whole favourable. Late winter frosts are rare and the warm sunny summers favour the production of fruit of excellent flavour and keeping quality. The main drawback arises from the fact that the winters are generally too short and too mild to give the trees the rest

required for normal growth and the production of large fruit crops. Thus whereas in the main producing areas of the northern hemisphere the dormancy period, when the mean temperatures are below the critical value of 54° F., exceeds 150 days, in the south-western Cape it averages only 90 days.[4] After mild winters the trees suffer from 'delayed foliation'[5] resulting in abnormal growth and low fruit yield.[6]

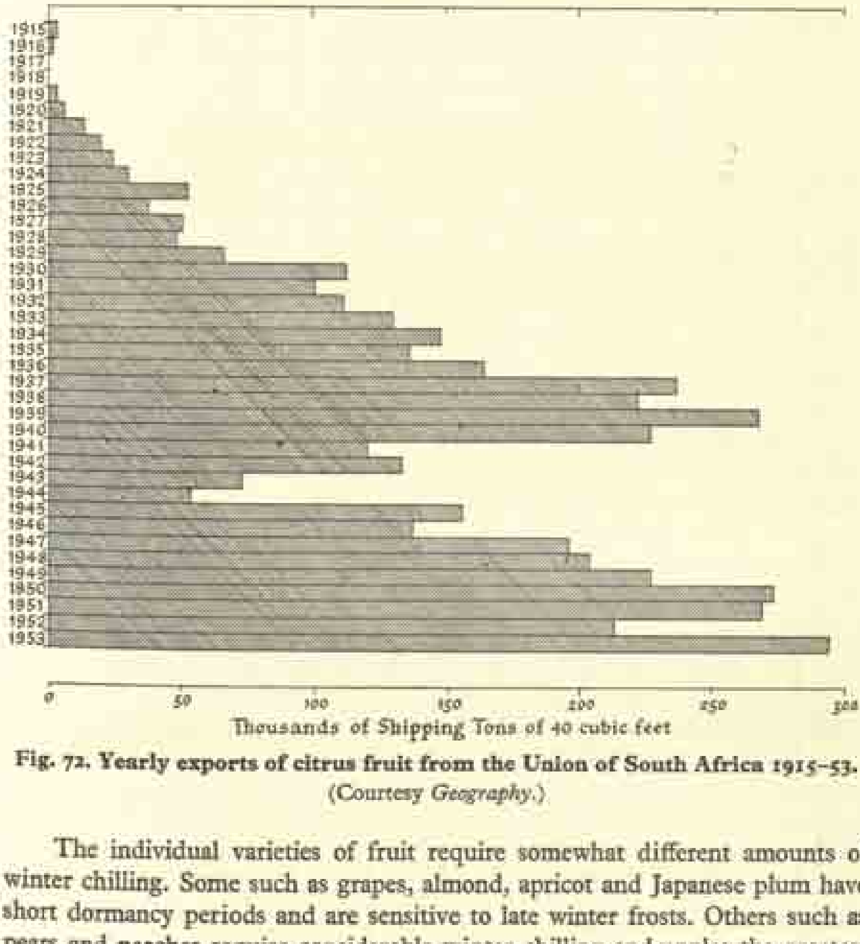


Fig. 72. Yearly exports of citrus fruit from the Union of South Africa 1915–53.
(Courtesy *Geography*.)

The individual varieties of fruit require somewhat different amounts of winter chilling. Some such as grapes, almond, apricot and Japanese plum have short dormancy periods and are sensitive to late winter frosts. Others such as pears and peaches require considerable winter chilling and apples the greatest amount. In terms of mean winter temperatures the upper limit for apples is 48° F., for pears 50° F., for plums, apricots and peaches 52° F., for almonds 54° F., and for grapes 56° F. For the production of choice fruit of good keeping quality each kind of tree has optimum temperature requirements during the period of active growth. Thus for peaches and pears the mean summer temperatures should exceed 75° F., for apricots they should lie in between 69° and 73° F.,

Table 6. The Temperature Conditions in some of the Leading Deciduous Fruit-growing Areas of the south-western Cape

Producing Areas	Altitude (feet)	Temperatures. Degrees F.				Leading Fruits
		June and July		December to February		
		Mean	Mean Minima	Mean	Mean Maxima	
1. Ceres Basin (Ceres 1882–1940)	1497	49–52	36–8	70–2	85–8	pears, peaches, plums
2. Montagu (Montagu 1936–40)	730	52–4	41–2	69–72	83–6	apples, pears
3. Elgin Basin (Elgin 1927–40)	846	49–51	37–8	64–7	76–9	apples, peaches, pears
4. Hex River Valley (De Doorns 1925–36)	1570	52–5	41–4	70–2	84–6	grapes, pears
5. Langkloof (Uniondale 1891–4)	2240	50–4	37–9	68–71	82–6	apples
6. Worcester-Robertson (Worcester 1932–40)	660	53–5	43–4	70–4	83–6	grapes
7. Groot Drakenstein (1899–1940)	480	53–5	43–4	70–4	83–6	grapes, apricots, plums
8. Tulbagh-Wolseley (Porterville 1934–40)	463	53–5	41–4	72–6	86–9	plums, prunes, apricots, pears
9. Paarl-Wellington (Wellington 1879–1902)	350	54–6	44–6	73–6	85–8	grapes, apricots
10. Stellenbosch (Elsenburg 1903–40)	594	54–5	43–7	68–71	80–4	grapes, pears, plums
11. Somerset West (1934–40)	26	53–5	44–5	68–71	78–82	grapes
12. Constantia (Groot Constantia 1888–1936)	200	55–6	48–9	66–9	75–7	grapes

for apples between 60° and 70° F., and for plums between 62° and 68° F. Grapes are less exacting producing good crops with summer temperatures ranging between 65° and 85° F.

The winter and summer temperatures for the leading deciduous fruit-producing areas of the Cape are given in Table 6. From this it is at once apparent that most areas have winter means between 52° and 54° F., and hence are marginal for most varieties of fruit. Because of the brevity and mildness of the dormancy period those varieties requiring little chilling are the most widely grown. Grapes are most important, while of the total of 15½ million deciduous fruit trees 5½ million are peach and over 3 million apricot. Apples, grown mainly in response to the demand on the home market, are, with 2½ million trees, the most important of the harder fruits; there are smaller numbers of pear and plum trees.

The distribution of the various types of fruit grown between the several valleys and basins is closely related to the temperature conditions which in turn depend mainly on altitude (Figs. 73 and 74). Thus apples are grown mainly in the Elgin basin[7, 8] and the Langkloof with smaller quantities coming from the Cold Bokkeveld and Koo. Only in these localities is found the combination of sufficiently cold winters and relatively cool summers. The Elgin basin is the most important producer, accounting for about half of the South African annual export of 8,000 tons; the Langkloof contributes one-third. Pears, which form the largest of the dessert fruit exports from deciduous trees (Fig. 71), are grown mainly in the Ceres basin and the Hex river valley where, at higher altitudes nearer the interior and hence removed from maritime influences, cold winters are combined with hot summers. Peaches are more widely grown but the Elgin and Ceres basins account for the greater part of the dessert fruit export which, however, has dwindled since 1939. Plums are also widely grown but the conditions are nowhere particularly favourable for them and the number of trees is relatively small. The Ceres basin produces about one-quarter of the export of dessert plums and Fransch Hoek and Groot Drakenstein together a similar quantity. High quality prunes come from the Winterhoek valleys near Tulbagh. The Paarl–Wellington, Stellenbosch and Somerset West areas, and the Constantia Valley, with their high winter temperatures, are really suitable only for apricots and vines. The former are grown mainly in the Wellington area where the greater part of the crop is dried, the hot dry sunny summer days being particularly favourable for this purpose. Grapes, being less exacting in their temperature requirements are more widely grown than other deciduous fruits but whether they are grown for dessert, wine or drying purposes, depends very much on the summer temperatures of the locality.

Within the various valleys and basins the siting of the orchards is influenced very largely by soil and drainage considerations. Well-drained slopes carrying loam soils, derived from the Bokkeveld Shales in the high mountain basins and from Malmesbury Shales or alluvium in the lower valleys, are most suitable. These soils possess good water absorbing and retaining capacities and while they

are naturally poor in humus and mineral salts their fertility is readily built up under cultivation. Their texture varies from one area to another and these variations are of some significance in the choice of fruit grown. Thus the fine textured rather heavy clay soils of the Ceres basin have favoured the establishment of pear

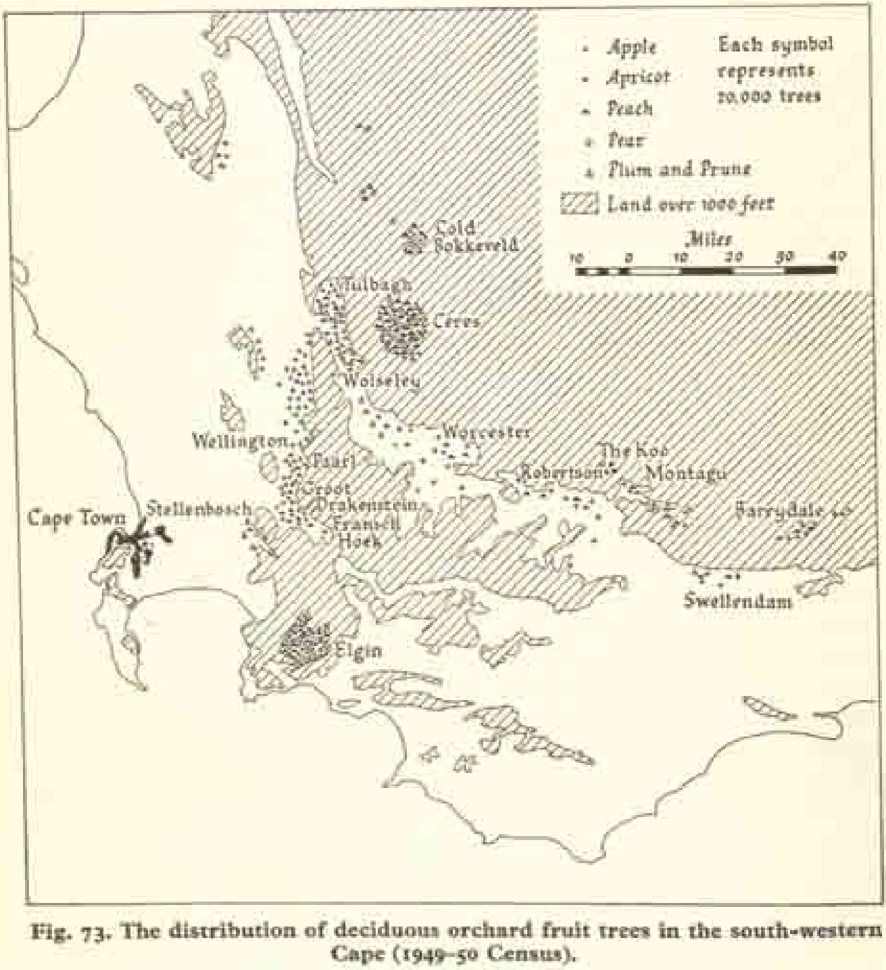


Fig. 73. The distribution of deciduous orchard fruit trees in the south-western Cape (1949–50 Census).

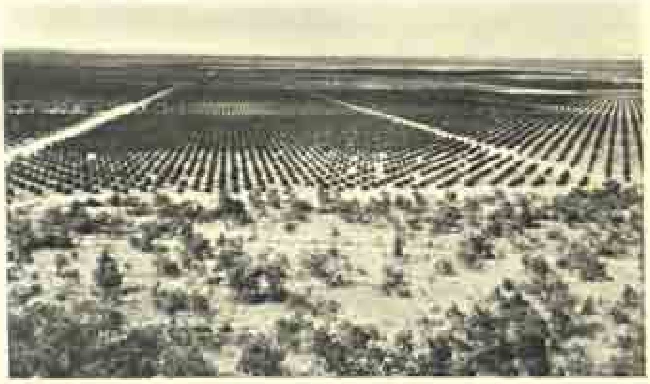
For details of relief and drainage and communications, see Fig. 185.

and apple orchards whereas the rather gravelly loams of the Elgin basin partly account for the large acreage under peaches in an area climatically more suited to apples.

While there is a high degree of specialization in the individual valleys and basins nevertheless each produces a variety of different fruits. For this there are several reasons. Most growers are anxious to spread the risk of unfavourable

44. Vineyards in the Paarl area. The vines, being for wine grapes, are not trellised. In the background the Drakenstein mountains and Bains Kloof which, until the opening of the road over Du Toit's Kloof in 1949, carried the main road over the Cape mountains to the interior. It still provides the direct route to Ceres.

45. The Hex river valley, a syncline in the Cape mountains. Outcrops of Table Mountain Sandstone build the Hex river mountains (seen in the background with the valley-ward dip of the rocks clearly visible), which enclose the valley on the west, and the Kwadouwsberg on the east. Within the valley the Bokkeveld shales, in the foreground overlain by Tertiary to Recent sediments, are preserved. These produce excellent soils for vineyards which occupy most of the cultivated land. The vines in the foreground are trellised for table grapes whose export is facilitated by the main line railway (on the right). The main road follows the railway.



46. Zebediela (Citrus) Estates, claimed to be the largest single citrus-growing estate in the world. The orange groves stretching across the Springbok Flats from the foot of the Strydpoort range, where dams have been built across the Gompies and Zebediela rivers to provide the necessary irrigation water. In the foreground the Bushveld vegetation.

47. A papaw plantation in the Transvaal Lowveld. Papaws are second in importance among the sub-tropical fruits grown in South Africa, often being grown on newly cleared land whose soil fertility is being built up prior to the planting of citrus trees. Papaws bear fruit nine months after planting.

48. Citrus groves in the Bushveld Basin near Rustenburg. The trees are protected from the cold southerly winds which sweep over the Highveld in winter, by the Magaliesberg (in the background). They are irrigated from the Olifants Nek Dam.

climatic conditions and also to lengthen the picking season (see Fig. 75) and so distribute their labour requirements. Local variations of climate and soil often enable them to do this. Thus in most areas there are valley bottoms and depressions where cold air associated with temperature inversions accumulates on

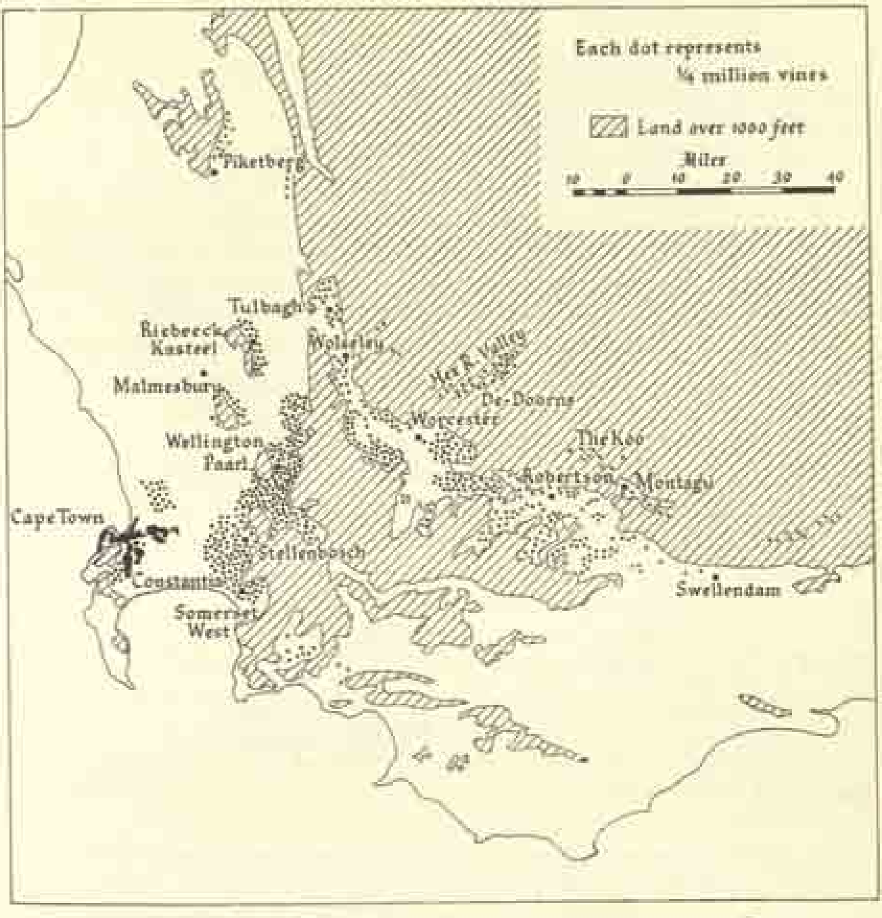


Fig. 74. The distribution of vineyards in the south-western Cape (1949–50 Census).

For details of relief and drainage and communications, see Fig. 185.

winter nights and produces minima below those for the locality. Aspect is also important, north-facing slopes being warmer than south-facing ones, east-facing than west-facing. The influence of microclimate is clearly seen in the distribution of the various types of fruit in the Elgin basin[9] (see ch. 36, p. 543) where apricot orchards and vineyards are found on some of the north-facing slopes, peach orchards occur on the flat tops and upper slopes of the hills and apple and pear

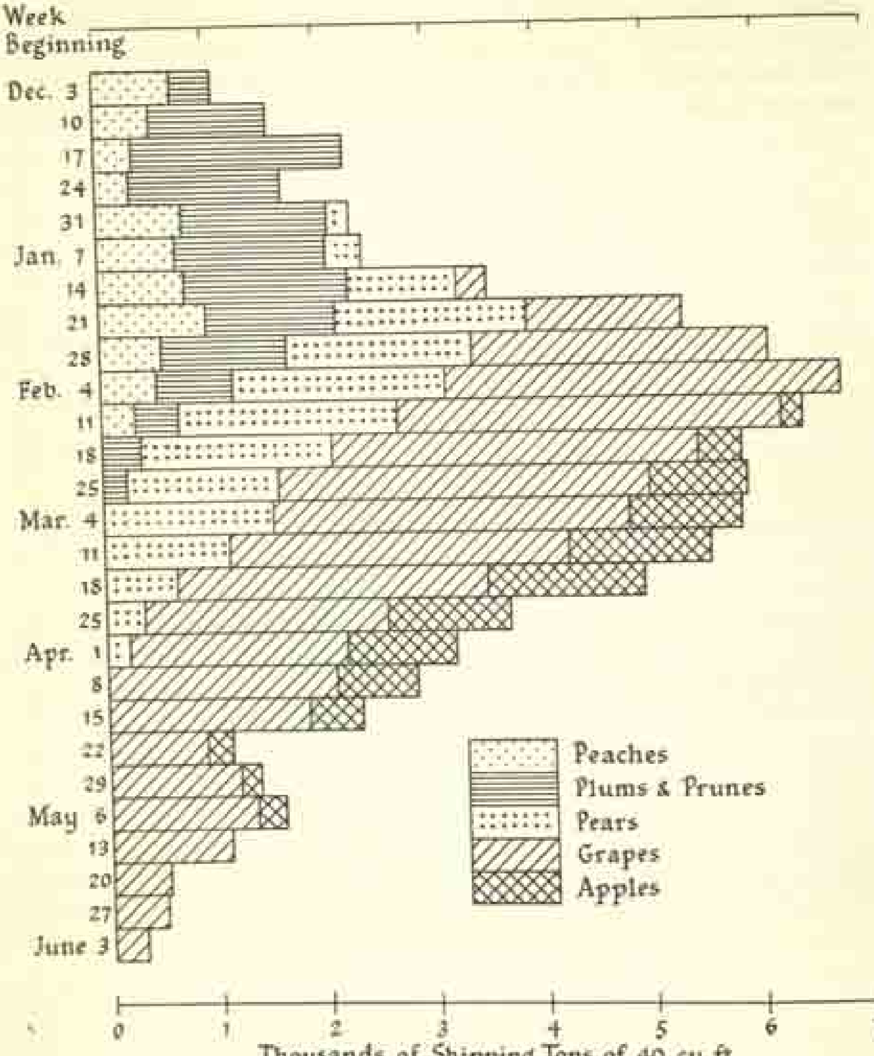


Fig. 75. The 1937–8 deciduous fruit export season, weekly shipments.
(Compiled from data given in the Union of S.A., Dept. Agric., report on the 1937–8 deciduous fruit export season.)

orchards occupy the lower slopes and valley bottoms (Plate 42). Variations of soil, however, are also partly responsible for this zonal arrangement, the gravelly soils of the upper slopes favouring peach and the clays of the valley bottoms apple and pear trees.

Generally speaking the winters are too mild for berry fruits,[10, 11] but strawberries,[12] Cape gooseberries,[13] youngberries, and booysenberries are grown in

the colder valleys, the two first mentioned on the more sandy soils, the last two on heavy vlei lands, sometimes being interplanted in pear orchards.

The deciduous fruit production of the south-western Cape is in excess of the home requirements, while the area as a whole is well placed for export. In fact the growth of the industry in this area has gone hand in hand with the growth of the export trade. Those areas in close proximity to Cape Town or served by the Mafeking–Cape Town railway send large quantities of dessert fruit overseas. Most important are table grapes from the Hex river valley, Paarl, Constantia and Somerset West, pears from Ceres and the Hex river valley, peaches from Elgin and Ceres and apples from Elgin. The more remote areas dry large quantities of fruit or increasingly send it to local canning and jam factories.

During the course of its growth the deciduous fruit industry of the south-western Cape has passed through several phases. Originally concerned with the production of wine and dried fruits, with the growth of refrigeration and rapid transport during the inter-war years the production of dessert fruit became important. Since 1939 with the wartime loss of export markets for dessert fruits, the establishment of canning and jam making factories, and shortages of agricultural labour consequent on industrial development in the towns, the fruit growers have turned their attention increasingly to canning varieties which have a longer picking season and do not require careful packing. Already practically the entire peach crop, and increasing quantities of pears, go to the canneries.

Today deciduous fruit is produced on scientific lines and marketed under highly organized conditions in the south-western Cape. The orchards are protected from the strong north-westerly winds of winter and the south-easters of summer by windbreaks, while oil sprays are used to induce dormancy. The vineyards are widely spaced and those producing table grapes are trellised in order to avoid sunscorch and damage from early autumn rains. The Western Province Fruit Research Station at Stellenbosch is, among other activities, evolving new varieties adapted to the marginal climatic conditions. Among its achievements is the Kakamas Cling peach, acknowledged to be one of the finest canning peaches in the world, which was bred from the fruit of a tree growing in one of the Orange river settlements. At the same time the fruit growers are increasingly growing cover crops, particularly lupins and vetches, between the orchard trees, in order to lessen soil removal and build up soil fertility. Some also are using part of their land for pasture and fodder crops and are engaging in dairying and other livestock enterprises in order to distribute their risks, spread their labour requirements, and at the same time obtain valuable manure for their orchards.

Compared with the south-western Cape the other deciduous fruit-producing regions are of minor importance. Yet until 1925 the Transvaal was the leading peach-producing province in the Union. The fruit was grown mainly on the irrigated lands along the Mooi river near Potchefstroom and along the Vaal river near Vereeniging as well as on the light granitic soils which could be irrigated

from the headstreams of the Crocodile river near Johannesburg and Krugersdorp. Large quantities of fruit are still produced in these areas but fruit growing is less important than it used to be for residential growth has swallowed up much of the orchard land near the cities, where in any case labour is a very real problem. Excellent apples are produced in the eastern Free State where the cold winters are exceptionally favourable for them while peaches and grapes are grown on the irrigated lands along the Orange river valley near Kakamas and Upington. Owing to the remoteness of the last mentioned area most of the fruit is dried, an operation facilitated by the very hot dry summers.

Viticulture

Viticulture is of outstanding importance among the fruit industries of South Africa. The annual vintage is valued at between £5 and £6 million and wine to the value of more than £1 million is exported annually. Table grapes, valued at about £½ million, make up 60 per cent of the tonnage of dessert fruit exported and raisins, sultanas, and currants form nearly 70 per cent of the annual production of dried fruits and more than 50 per cent of the exports.

The best climatic conditions for viticulture obtain in the winter rainfall area of the south-western Cape[14, 15] where the dry summers are favourable for ripening the grapes. Commercial viticulture is almost entirely confined to this region. The vine can also be grown in the drier parts of the summer rainfall area and recently its cultivation has been taken up on the Loskop irrigation scheme in the Bushveld. In areas with humid summers, however, the plant is susceptible to many fungoid and bacterial diseases while the grapes tend to be soft and watery.

Within the south-western Cape viticulture is carried on under a variety of temperature and rainfall conditions. The temperatures in any locality, however, very largely determine its suitability for table, wine, or raisin and sultana grapes and influence the choice of grape variety and the quality of the wine. For example where the mean summer temperatures exceed 85° F. the sugar content of the grapes is very high making them suitable for heavy sweet wines or for raisins or sultanas. Localities with summer temperatures between 75° and 85° F. produce the best table grapes[16] and those with summer temperatures between 65° and 75°F. produce the best light dry wines.[17]

Where the rainfall exceeds 20 inches concentrated in the winter months grapes may be grown without irrigation; where less is received irrigation is essential. In the Cape the vine-growing areas located in the Tulbagh and Ceres basins, in the valleys at the western foot of the folded mountains and on the slopes of the island-like mountains rising from the western lowland receive sufficient suitably distributed rainfall. Together these areas produce about 40 per cent of the average annual South African vintage of about 500,000 leaguers. In the Breede and Hex river valleys, which together produce about one-half of the vintage, in the valleys of the Little Karoo and along the Orange river, however, the vineyards must be irrigated.

In the Western Lowland the most important vine-growing areas are found on the granite slopes of Constantia, the Paardeberg near Malmesbury, and the Contreberg near Mamre Road and on the lower slopes of the Table Mountain sandstone masses of the Kasteelberg and Piketberg. Farther east, near the foot of the folded mountains vineyards similarly clothe the eastern slopes of the granite dome of the Paarl Berg which overlooks the Great Berg river valley. Viticulture is important also in the valley of this river (Plate 44) and its tributaries at Fransch Hoek, Groot Drakenstein, Klein Drakenstein, and Wellington and in the valleys leading to the Eerste river, particularly around Stellenbosch and Banhoek. In all these localities the summer temperatures and the light loam soils[18] favour the production of light wine grapes. Dry white wines of the hock type are produced. Those coming from Reisling stocks imported from the Rhineland are of high quality but most are produced from more drought-resistant French wine stocks and lack the bouquet of Reisling. The best light wines come from the Constantia valley, the oldest and most famous vine-growing area of South Africa. Here both dry red wines of the claret type and good quality sherries are produced. With its favourably distributed rainfall, moderate summer temperatures and light granitic soils the Constantia valley is important also for table grapes; its easterly aspect promotes the early ripening of the crop and proximity to Cape Town has encouraged export. Today those farms situated within seven miles of the railway concentrate on export grapes, the more distant ones on wine. Paarl, where again an easterly aspect is associated with an early harvest, also exports large quantities of table grapes.

Of the remaining non-irrigated vine-growing areas the Tulbagh basin is famous for the excellence of its Witsenberg wine.

Among the areas in which vines are grown under irrigation the Hex river valley is outstanding for the value of its vintage. This is due to a concentration on export table grapes for which the valley enjoys exceptional advantages. Occupying a broad syncline in the Table Mountain Sandstone between the Hex River and Kwadouw mountains (Plate 45) it possesses ample supplies of irrigation water derived both from the numerous mountain streams and from dependable boreholes; the latter are fed by the copious rains which fall on the mountains and percolate rapidly into the permeable sandstone. The valley is followed by the main Mafeking–Cape Town railway and, most important, experiences relatively cold winters which enable it to produce late-maturing grapes particularly Almeria, which coming on to the market after other varieties are over, command high prices. In the Breede river valley shortages of irrigation water (see ch. 7, p. 147 and ch. 36, p. 550) limit the acreage planted to vineyards and together with the high summer temperatures lead to a concentration on raisins and sultanas and on heavy sweet wines. Raisins are produced particularly around Goudini and sultanas and sweet wines in the Robertson–Bonnievale area.

Outside the south-western Cape the irrigation settlements along the Orange river between Upington and Kakamas have long been important producers of

sultana grapes, furnishing about 90 per cent of the South African output. Recently small irrigable areas in the Bushveld and Lowveld have been planted to vines with the object of producing table grapes for the early market.

Citrus Fruits

Citrus fruit[19] is grown under more varied environmental conditions in South Africa than in any other important producing country, being grown in several physiographic regions widely separated from one another and differing in relief, in surface form, in climate and soils.[20] The distribution of trees is shown in Fig. 76. Their concentration along the valleys of rivers draining to the Limpopo and Crocodile–Komati in the Transvaal and to the south-east coast in the Cape is marked. Less important producing areas occur along the Mooi river in Natal and the Olifants river in the south-western Cape.

Since citrus trees are highly sensitive to frost, commercial citriculture is limited to frost-free areas. Hence the groves are found only at altitudes below 4,000 feet in the marginal lowlands below the Great Escarpment and in the Bushveld basin. Within these areas, however, they occur at greatly varying elevations – a little below 4,000 feet in the Transvaal Bushveld, between 2,000 and 3,000 feet in the Lowveld, and at altitudes varying from 100 feet in the Sundays river valley to more than 2,000 feet in the Kat river valley in the south-eastern Cape. Naturally the trees succeed at higher altitudes near the tropics than in the southern part of the country.

Within the frost-free areas commercial citrus fruit production is feasible only where the moisture requirements of the trees can be met; these are equivalent to a rainfall of 30 to 40 inches so distributed that water is available during the period of active growth. It is particularly necessary during the blossoming and fruit-setting period, which in South Africa, lasts from August to November. Since the summer rainfall does not normally begin until well into October irrigation is essential for citrus fruit production in both the summer and the winter rainfall areas of the country. In effect this limits citrus fruit growing to the valleys of perennial rivers and accounts for the concentrations shown on the map. With irrigation citrus fruits can be grown in remarkably dry areas. The Olifants river valley in the Cape for example receives less than 10 inches and the Sundays river valley between 10 and 20 inches. In the citrus-producing areas of the western Transvaal which receive between 20 and 30 inches and the north-eastern Transvaal which receive between 30 and 40 inches, however, less irrigation is necessary.

Generally speaking climatic conditions are favourable for citrus fruit growing; frost is a danger only in the Kat river valley; elsewhere the winter minimum temperatures rarely fall below 40° F. and day temperatures average 70° F.; the summer temperatures, with daily maxima around 85° F. and nightly minima in the vicinity of 60° F., are well within the limits for growth – 55° to 100° F. – and approach the optima for sweet oranges – 73° to 91° F. – in the

western Transvaal and the Lowveld. The only drawback is the danger of excessively high temperatures combined with low atmospheric humidity which may be experienced in inland localities in September. Generally speaking in the Transvaal the hot days and warm nights and thunderstorm rains during summer promote vegetative growth while, in winter, the lower temperatures, absence of rainfall and abundant sunshine favour the ripening of the fruit. In the south-eastern Cape the seasonal rhythm is similar but there is less variation in temperature and humidity and the rainfall is more evenly distributed throughout the year. Differences of climate between the several producing localities influence the types of citrus fruit grown. Grapefruit production is practically confined to the Sundays river valley where conditions are most equable. The best oranges, however, are produced in the inland localities where the more abundant sunshine, higher temperatures and lower humidities favour the concentration of the sugar content and the deepening of the colour.

The soils vary considerably between the main producing areas. Along the river valleys of the southern Cape and the Mooi river of Natal they are mainly deep loams of alluvial origin. On the Springbok Flats in the Transvaal Bushveld, Zebediela Estates have been laid out in deep black soils weathered from basaltic lava. Where well-drained these soils, with their neutral to alkaline reaction and high calcium content, are eminently suitable for citrus fruits. Elsewhere the soils are less favourable. In the western Transvaal the citrus groves have been established on soils which, derived from an admixture of quartzite and diabase, are rather sandy and deficient in plant nutrients, while in the Lowveld they occur on lateritic red earths (see ch. 4, p. 83) which are highly leached and generally deficient in calcium, potash, and available phosphates.

Owing to the diversity of climatic and soil conditions the South African citrus industry is beset with more varied problems than in most other countries. The most serious problems are associated with irrigation practice and soil nutrition. In some producing areas the supply of irrigation water is inadequate either because the area was overplanted relative to the amount of water available or because the siltation of reservoirs has reduced the storage. The former is the case on the Zebediela Estates (Plate 46), the latter in the south-eastern Cape where it has actually led to the abandonment of land in the Fish river valley. Both here and on the Springbok Flats citrus growing, for which the climate is favourable and the soils excellent, could be extended if more irrigation water was available. In the south-eastern Cape certain problems have arisen in the past as a result of the high alkali content of the irrigation water (see ch. 7, p. 144). Thus in the Sundays river valley citrus trees suffered defoliation when, as a result of the breakdown of the soil structure caused by a concentration of alkali salts, the movement of moisture in the soil became so sluggish that transpiration was arrested.[21] With adequate drainage, however, these troubles can be avoided.

Generally speaking citrus trees flourish best on neutral to alkaline soils and it is where they have been planted in acid soils that problems of soil nutrition have

been experienced.[22] These are most serious in the Transvaal Lowveld where the lateritic soils have an acid reaction and high phosphate fixing capacity.[23] Here despite the liberal application of phosphatic fertilizers, the phosphorus becomes fixed and unavailable to the trees. It has now been found that the problem is aggravated by the use of ammonium sulphate which increases the acidity of the soil and the use of calcium nitrate as an alternative source of nitrogen has been advocated. Meanwhile experiments with the concentrated application of phosphatic fertilizers around the root zone of the trees and with the use of foliar sprays have brought some improvement. A deficiency in the intake of phosphorus has hitherto been considered responsible for the high acid/sugar ratio of many Lowveld oranges;[24] but oranges from other producing areas also tend to be sour and it now seems probable that this is due in part to the use of rough lemon rootstocks, the American sour-orange stock failing under South African conditions. With a view to improving the quality of the fruit experiments are being made with sweet orange rootstocks[25] at the Nelspruit Sub-tropical Horticultural Research Station and the results so far obtained are encouraging.

Because of differing environment conditions the organization of the citrus industry, the variety of fruit grown and the farming practices differ from one producing area to another.

The western Transvaal is one of the oldest citrus fruit-producing areas in the country and hence still has a number of seedling orange trees. These, however, are being gradually replaced by Washington Navel and Valencia Late varieties. Most of the production is in the hands of small growers who either send their produce to the central pack-house at Rustenburg or else pack it and despatch it individually from the main stations on the Mafeking–Johannesburg railway line. The production has tended to decrease in this area as some of the orchards are becoming old and are not being replaced. Generally speaking the conditions here are less favourable than in the north-eastern Transvaal and south-eastern Cape. Low humidities and strong winds are liable to occur in August and September before the rains; these are harmful to the blossoms and newly-set fruit while the vitality of the trees is lowered as a result of partial defoliation. Moreover supplies of water are inadequate in some areas. As a result, the area is losing ground to other more favoured areas. Citrus fruit is usually the sole concern of the growers in this area.

The northern and north-eastern Transvaal normally produces a large part of the South African citrus crop. Here much of the acreage is in the hands of large companies, Zebediela Estates (see ch. 42, p. 647), with over half a million trees, being reputed to be the largest single citrus estate in the world (Plate 46), and Letaba Estates, east of Tzaneen, the second largest. Individual growers, however, are numerous in the Duivelskloof–Tzaneen area. On the large estates citrus fruit is the sole concern but the smaller farmers grow other sub-tropical fruits and vegetables as well. Normally about 75 per cent of the citrus crop is exported, the producing districts being served by the Messina–Johannesburg and Pietersburg–

Komatipoort railways. Most of the produce moves to Cape Town via Johannesburg, the rest to Lourenço Marques.

In the eastern Transvaal[38] there are one or two large companies but most of the production is in the hands of small growers. On both the large and small estates a variety of other sub-tropical fruits and out-of-season vegetables are grown in addition to citrus fruits (see ch. 38, p 593.). There is a co-operative

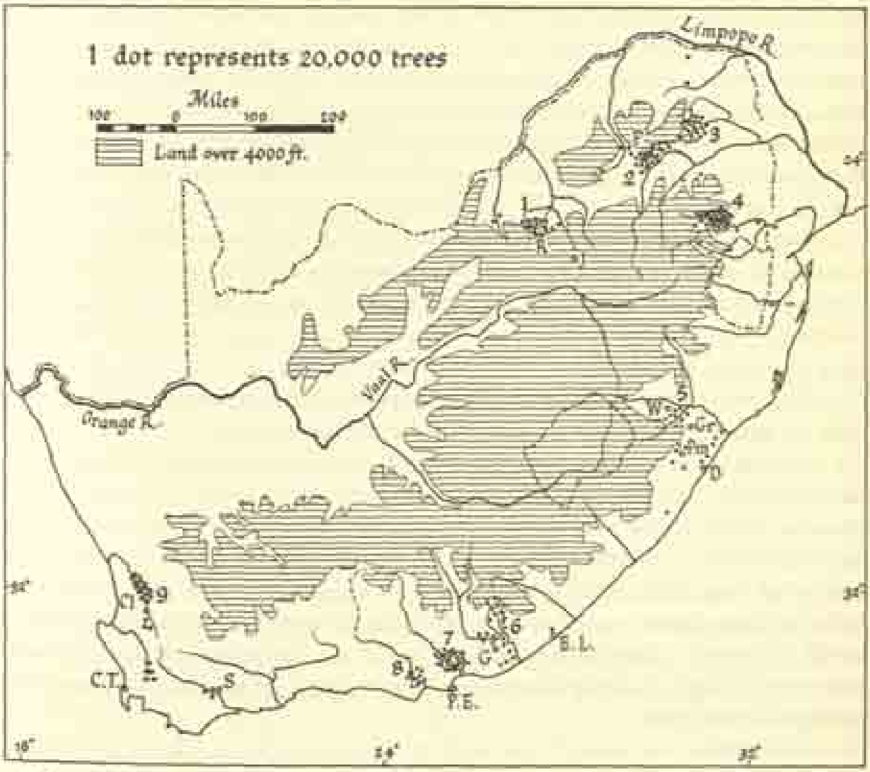


Fig. 76. The distribution of citrus fruit trees in the Union of South Africa.
(Courtesy *Geography*.)

pack-house at White River but many growers pack and ship their produce individually. The area enjoys excellent rail facilities, the main Johannesburg-Lourenço Marques railway following the Crocodile river valley. Despite proximity to Lourenço Marques most of the fruit moves to Cape Town where there are better handling and shipping facilities.

In both the northern and eastern Transvaal Valencia Late oranges do better than Washington Navels and occupy the largest acreages. Navels are grown, however, along with mid-season varieties, especially Mediterranean Sweet, in order to spread the picking season. Generally speaking the temperatures are too

variable and the humidity too low for grapefruit although small quantities are grown.

In the south-eastern Cape the Sundays river has long been one of the most important citrus fruit-producing areas in the country. The groves stretch for a distance of 25 miles along the valley and are irrigated from water stored in Lake Mentz. The fruit is grown by individual farmers who belong to the co-operative pack-house at Addo.[27] On most farms citrus production is combined with dairying and poultry raising, which are encouraged by the nearby market in Port Elizabeth. The equable temperature and humidity conditions in the valley favour grapefruit which furnish a large part of the export while the deep loam soils make possible the growing of good quality Navel oranges. The area enjoys the further advantage of proximity to Port Elizabeth (only 35 miles from the central pack-house) where the fruit is either shipped overseas or processed in the canning and jam factories.

The production from the other citrus-growing areas is relatively small.[28] Conditions in the other valleys of the south-eastern Cape resemble those in the Sundays river valley and Navel oranges form the major output. In the Mooi river valley of Natal the groves were originally laid out by a company which later sold the plots to individuals. The company still retains large interests in the industry. Most growers belong to a co-operative pack-house whence the fruit is sent by railway bus to Greytown and then by rail to Durban.

During the past fifteen years there has been a marked shift in the main areas of production. The Sundays river valley has maintained a steady output, but the western Transvaal has suffered a slight decline while the industry has expanded and still continues to expand in the northern and eastern Transvaal where the control of malaria has opened new areas for settlement. Here considerable areas suited to citrus fruits await clearance. In the south-eastern Cape citrus production could be greatly extended if additional water for irrigation became available (see ch. 7, p. 146). Such developments, however, will depend partly on overseas markets for the fruit.

Today there are around 5 million citrus trees in the Union; of these 4 million are orange, over ½ million are grapefruit, and the remainder naartjie and lemon. The fruit production averages about 350,000 shipping tons (about 200,000 tons of 2,000 lb.). More than half of this is exported, mainly to the U.K.

The bulk of the export crop consists of Valencia Late and Washington Navel oranges. Smaller quantities of grapefruit are also exported. The first shipments reach the U.K. towards the end of May and reach a first peak at the beginning of July (Fig. 77). These shipments consist of Navel oranges and grapefruit and meet the competition of the late-season crops from Brazil where the climate is more favourable and production costs lower. There is a lull in the South African citrus export in late July and early August but from then onwards the Valencia Late oranges are ready and shipments increase until the peak is reached in late September. The fruit reaches England when there is little com-

petition from other countries although Navels from Palestine and new seedless varieties from Spain compete with the South African produce for the early November market. However, generally speaking, the South African fruit reaches

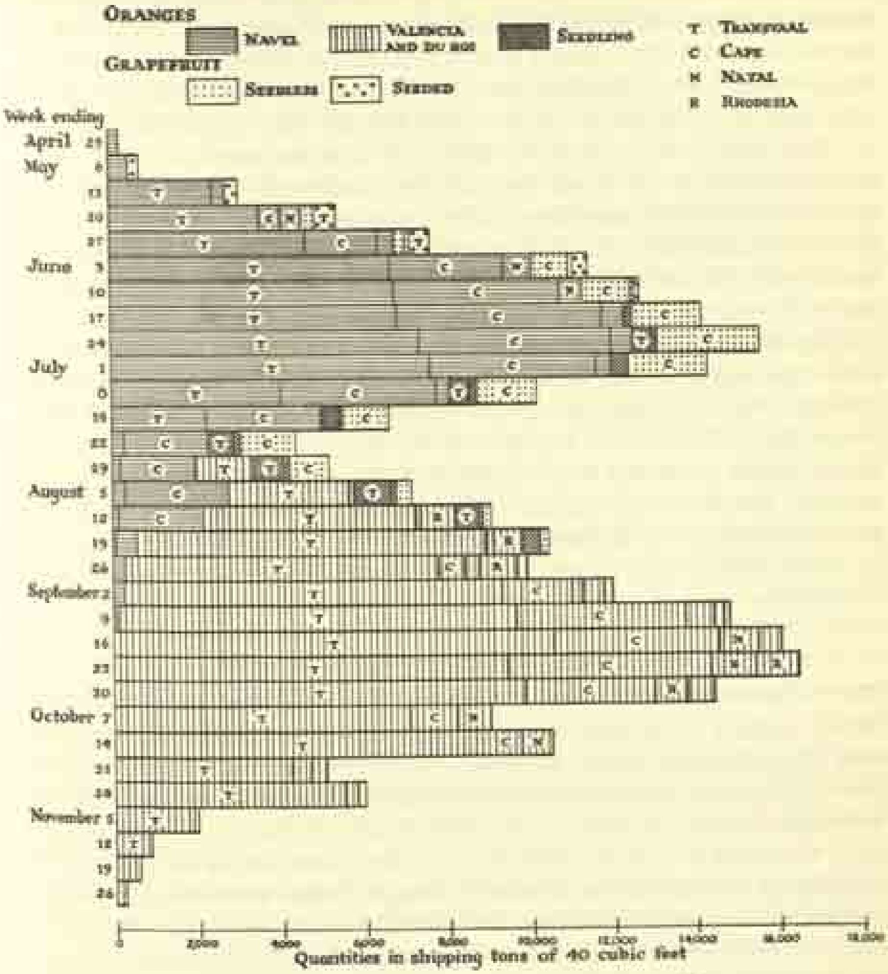


Fig. 77. The 1939 citrus fruit export season, weekly shipments.
(Compiled from data given in the Union of S.A., Dept. Agric., report on the 1939 citrus export season.)

the English market when there is little competition from other producing countries. Market conditions generally favour Valencia production, a factor which has fostered increased plantings in the Lowveld where the climatic and soil conditions are most suitable for this variety.

The citrus export season is fairly well spread through the months of May to

October. This is due partly to differences of climate resulting in earlier crops from the Transvaal than from the Cape, while different varieties are grown to lengthen the season. The crop is exported mainly through Cape Town; the Sundays river fruit, however, moves through Port Elizabeth and some of the Transvaal fruit through Lourenço Marques. Generally speaking, however, it is desirable to get the produce on the U.K. market as early as possible and hence the saving of time which results from despatching the Transvaal fruit to Cape Town by railway more than offsets the lower cost but longer journey from the Mozambique port.

The South African citrus fruit industry is organized on a co-operative basis and care is exercised to ensure that only high quality fruit is exported. Owing to the differing physical conditions under which the fruit is grown it has been difficult to standardize the produce exported. The fruit, however, is tested for soundness, for solids/acid ratio, and for juice content. Only that of high quality is passed for export and the brand 'Outspan' commands high prices on the British market. At present the industry suffers from low fruit yields and high production costs. The Nelspruit Sub-tropical Horticultural Research Station is at present concerned with the provision of new rootstocks and budwood and with overcoming the problems of soil nutrition. On the success of their work bringing, it is hoped, higher yields and better quality fruit, largely depends the future of the industry. South African fruit has long enjoyed tariff protection on the United Kingdom market, but increased production may necessitate finding new markets in Europe and elsewhere, in which case high quality fruit and reduced production costs will be vital.

Other Sub-tropical and Tropical Fruit

The production of sub-tropical and tropical fruit other than citrus varieties is largely confined to the frost-free areas of the eastern coastal plain and the Lowveld. Here the warm winters are favourable but because the rainfall is seasonal tree crops require irrigation and hence can be grown only in the vicinity of perennial streams. Of all the fruits grown pineapples are the most important; along with bananas they are grown mainly in the coastal belt where there is little variation of temperature and humidity. Mangos, litchis, avocados, papaws, and granadillas are produced mainly in the Lowveld where there are also plantings of tung nut trees. Guava trees which prefer somewhat cooler conditions are more widely distributed – in the Paarl valley of the south-western Cape, in the coastal zone near East London, and in the Lowveld. Since most of the sub-tropical fruits thrive best within a narrow range of climatic and soil conditions each has a somewhat localized distribution.

Pineapples[29,30] were first grown in Natal but at present the main producing areas are in the eastern Cape around Bathurst, East London, and Peddie, where the climatic conditions resemble those of Hawaii, with fairly uniform temperatures, averaging between 70° and 80° F., throughout the year and a well-distributed rainfall of between 25 and 30 inches. Farther north the climate is equally suitable

but the country is more hilly and since pineapples are planted in rows and clean cultivated soil erosion is likely on slopes exceeding 12 per cent unless expensive protective measures are employed. Generally speaking bananas are more profitable on such hilly land. Since 1937 the acreage under pineapples has increased threefold, encouraged by the good market in the United Kingdom consequent on the falling off in supplies from Malaya and Hawaii. The establishment of a cannery at East London led to the laying out of pineries in the neighbourhood while more recently a similar development has encouraged planting in the Transvaal Lowveld, where, however, the greater extremes of temperature are less favourable. In the south-eastern Cape the well-drained red soils derived from dolerite carry most of the pineries, the lighter loams being devoted to the smaller 'Queens' and the heavier soils to the recently introduced 'Smooth Cayennes' for canning. Environmental differences necessitate some departure from the cultural practices of Hawaii. Thus the rows are not 'paper mulched' in order to lessen evaporation and reduce the cost of weeding, for not only is paper scarce in the Union but white ants readily attack it. Near the coast blown sand is a problem necessitating the provision of wind-breaks. These are usually of Napier Fodder, which provides stock feed. Normally the pineapple plants flower in spring and the main crop is harvested from January to March. Some flowering, however, takes place in late summer and provides fruit in July and August. Recently this tendency has prompted the use of growth regulating hormone sprays for lengthening the fruiting season, a development made possible by the warm winter.

Some measure of the recent growth of pineapple cultivation may be gauged from the fact that between 1938–9 and 1950–1 the quantity of pineapples sent to the canneries increased from 4,000 tons to 30,000 tons while the export of fresh fruit increased from less than 2,000 tons to over 12,000 tons (over 300,000 cases) valued at more than £½ million.

Papaws (Plate 47) rank second in value among the sub-tropical fruits, production having increased rapidly as a result of the large plantings made since 1937. Indeed the acreage and the number of plants has doubled since this date. Commercial papaw production is almost wholly confined to the warmer parts of the Lowveld; it is particularly important around Ofcolaco and Kaapmuiden where papaws are often the main concern of the farmers; around Nelspruit, however, they are grown only on soils too sandy for citrus and other sub-tropical fruit trees or are interplanted between young trees which have not reached the bearing stage. The great increase in the acreage under papaws is due very largely to the ease with which they are grown, to the fact that they bear after only nine months and form a useful cash crop while groves of citrus and other sub-tropical trees are being established. Moreover there is a ready market for the fruit in the Union. Production, however, now exceeds home needs and the fruit is too highly perishable to be exported in a dessert state. Unfortunately it is not possible to tap the fruit for papain, which is greatly in demand for use in digestive medicines and meat tenderizers, because the dry atmosphere in winter, when the tapping would

have to be done, causes the latex to solidify on the fruit. A beginning has been made with canning the fruit but as yet the scale is small.

The factors responsible for the expansion of papaw production have likewise led to a big increase in banana cultivation since the war. Both in quantity and value bananas are third among the sub-tropical fruits. Production centres mainly in the coastal belt of Natal where the uniformly high temperatures and humidities and the fairly well-distributed rainfall are favourable. The fruit is grown mainly by Indians in very small plantations along the sheltered valleys near the coast and on the steep hillsides between Durban and Pinetown, in both areas occupying land unsuited to sugar cane. Since 1945 banana growing has become important also along the southern slopes of the Soutpansberg and in the higher and cooler valleys of the Lowveld of the Transvaal and Swaziland. Here the climatic conditions are generally favourable but the plants may suffer from occasional very high temperatures and low humidities. The plantations are owned by Europeans and are generally larger than those in Natal.

South Africa actually leads the world in the production and export of granadillas or passion fruit which thrive in the frost-free but cooler and more humid parts of the Lowveld and Middleveld. The market for this fruit, however, is very small and a large part of the crop is converted into squash.

The production of most of the sub-tropical tree fruits is still in its infancy although the number of mango, litchi, and avocado trees has more than doubled since 1937. These together with guavas are the most important. Mangos and litchis succeed only in the warmer parts of the Lowveld, but avocados and guavas do best in the cooler parts of this region and thrive also in the warmer districts of the south-western Cape. Mangos are the most widely grown, but the crop is usually small and the fruit of poor quality. By contrast in favourable seasons litchi trees yield big crops of high quality fruit in the Lowveld. The trees suffer to some extent from the dry atmospheric conditions (compared with their native South China), and the branches become so brittle that they must be supported by a framework of poles. In some seasons, too, heavy losses are experienced when, due to sudden changes of humidity, the fruit bursts before it is ripe. This danger, however, can be mitigated by liberal irrigation at the critical period. Both avocado and guava trees thrive in the cooler parts of the Lowveld and yield excellent crops. Guavas became important during the second world war when the discovery of their high vitamin C content, preserved even when they are canned, created a demand for them among the troops in North Africa and the Far East. This led to plantings in the Lowveld and the warmer parts of the Cape.

The future production of all these sub-tropical fruits hinges on two factors – firstly the breeding of new varieties capable of producing large crops of high quality fruit and secondly, the finding of markets overseas. Most of these fruits have only recently been taken up commercially and they have been introduced from countries in which scientific plant breeding has not been practised. Work being carried out at the Nelspruit Sub-tropical Horticultural Research Station,

however, promises to produce the required varieties. The question of markets is more difficult for, on the one hand, most of the fruits are highly perishable, and, on the other, the fruits are little known in Europe. Successful shipments of dessert litchis have been made to England and small quantities of both this fruit and guavas are exported in canned form. Mangos, however, are not popular in Europe and the export trade depends on opening a market in India where the fruit is always in demand and where the off-season coincides with the South African season. The export of avocados is limited by their highly perishable nature which makes air transport the only means of carriage. If and when marketing difficulties can be overcome the increased production of all these fruits is likely.

The picture with regard to tung nut trees is very different. Large plantings of these trees were made in the Middleveld and Lowveld when the outbreak of war in China threatened to cut off supplies of tung oil. In China, however, the nuts are gathered from wild trees and the oil extracted simply and cheaply. Yield is not important. In the absence of recognized varieties and with little knowledge of the correct cultural practices the South African plantations of tung trees, like those in the U.S.A. and East Africa, have been disappointing, the yield of both nuts and oil low and variable. Consequently when, at the end of the war with Japan, China flooded the market with accumulated stocks of tung oil and prices dropped, many of the trees in the Lowveld were uprooted and the land put to other use.

BIBLIOGRAPHY

1. M. W. BLACK. 'The deciduous fruit industry in South Africa'. *F. in S.A.*, Vol. XXVII, pp. 117–22.
2. C. J. THERON. 'Three centuries of viticulture'. *F. in S.A.*, Vol. XXVII, pp. 127–31.
3. R. H. MARLOTH. 'The citrus industry in South Africa'. *F. in S.A.*, Vol. XXVII, pp. 132–4.
4. G. D. B. de VILLIERS. *Climate and Its Relation to Deciduous Fruit Production.* S.A. Dept. Agric., Sc. Bull., No. 222, 1940.
5. G. D. B. de VILLIERS. *Climatology in relation to Land Use with special reference to the Influence of Climate on Fruit Growing.* African Regional Scientific Conference. Johannesburg, 1949, Comm. No. a(e) 2.
6. O. S. H. REINEKE. *Environment and Its Influence on Fruit Production.* S.A. Dept. Agric., Bull. No. 154, 1936.
7. T. MICKLEM and P. E. KRIEL. *The Deciduous Fruit Industry of the Western and South-western Cape Province.* S.A. Dept Agric., Bull. No. 321, 1951.
8. S. P. van WYK and A. R. HAVEMANN. *An Economic Study of Deciduous Fruit Farming in the Western Cape Province 1933–4 to 1935–6.* S.A. Dept Agric., Sc. Bull., No. 183, 1939.

9. See M. M. COLE. 'Elgin. A land utilization survey'. *S.A.G.J.*, Vol. XXXI, 1949, pp. 1–41.
10. O. S. H. REINEKE. 'Berry fruits in the winter rainfall area'. *F. in S.A.*, Vol. V, 1930.
11. T. MICKLEM. 'Berry fruits'. *F. in S.A.*, Vol. XVIII, 1943.
12. T. MICKLEM. 'Strawberry culture'. *F. in S.A.*, Vol. XXVII, 1952.
13. T. MICKLEM. 'Cape gooseberry culture in the western Cape Province'. *F. in S.A.*, Vol. XXIV, 1949.
14. P. R. V. d. R. COPEMAN. 'Studies in the growth of grapes'. *T.R.S.S.A.*, Vol. XIV, 1927.
15. HENRIETTE F. THERON. 'Geografiese invloede op die wynbow in Suid Afrika'. *S.A.G.J.*, Vol. XV, 1932.
16. A. M. du PLESSIS. 'Table grapes'. *S.A. Dept Agric. J.*, Vol. X, 1925.
17. C. J. THERON. 'South African wines'. *Die Wynboer*. Cape Town. April 1947.
18. M. S. du TOIT and P. de V. DANEEL. *The Distribution and Nature of the Paarl Table Grape Soils*. S.A. Dept Agric., Sc. Bull., No. 202, 1940.
19. R. A. DAVIS. *Citrus Growing in South Africa*. Govt. Printer. Pretoria. 1919.
20. MONICA M. COLE. 'The growth and development of the South African citrus industry'. *Geog.*, No. 184, Vol. XXXIX, Part 2, 1954.
21. J. J. THERON. *Alkali and Irrigation Studies with Citrus Trees in the Sundays River Valley*. Univ. of Pretoria Publ., Series No. 1, Agriculture No. 40.
22. P. C. J. OBERHOLZER. 'The influence of soil pH on citrus'. *F. in S.A.*, Vol. XIX, Nov. 1944.
23. P. C. J. OBERHOLZER. *The Present State of Citrus Nutrition in South Africa*. S.A. Dept Agric., Bull. No. 271, 1946–7.
24. D. J. ESSELEN and P. C. J. OBERHOLZER. 'Reduction of acid in Valencias'. *F. in S.A.*, Vol. XIV, 1939.
25. R. H. MARLOTH. *Sweet Orange as Rootstock for Citrus*. S.A. Dept Agric., Bull. No. 302. Hort. Ser. 15. Pretoria. 1949–50.
26. See MONICA M. COLE. *Land Use Studies in the Transvaal Lowveld*. The World Land Use Survey. Occasional Papers, No. 1. Geographical Publications. 1956. Contains also a full bibliography.
27. See A. L. PRINSLOO. *An Economic Survey of Citrus Growing in the Union*. S.A. Dept Agric., Bull. No. 221, 1941.
28. See S. D. NEUMARK. *The Citrus Industry of South Africa, its National and International Aspects*. Witwatersrand University Press. 1938.
29. 'The pineapple in South Africa. Proper planting for pineries'. *F. in S.A.*, Vol. XXVI, 1951.
30. J. C. le ROUX. 'The pineapple in South Africa. Cultivation, control of pests and diseases'. *F. in S.A.*, Vol. XXVI, 1951.

13

The Pastoral Industries

Introduction

South Africa is traditionally a pastoral land and even today, despite the great extension of crop production during the present century, livestock enterprises still dominate her agricultural life and account for the major share of the agricultural income. For this the physical environment is largely responsible.

Both cattle and sheep are indigenous to Africa and before the coming of the Europeans the peoples of Southern Africa engaged in nomadic pastoralism. The native sheep kept by the Hottentots were long-legged, fat-tailed creatures covered only with hair and kemp and well adapted to the hot arid conditions of the Cape interior. The cattle, owned by both Hottentot and East Coast Bantu, were humped thick-skinned beasts able to endure drought and high temperatures and to combat the bites of ticks and flies. Native sheep and cattle, obtained by barter, provided the foundations of the early European-owned flocks and herds. These increased in size very rapidly as the pioneers spread over the country occupying in turn the Southern Cape and later the Highveld plateau. Cattle were prized mainly as draught animals for pulling the voortrekker wagons, and bred for strength and endurance. Sheep provided the needs of meat and fat. Generally speaking the native cattle gave little milk and yielded poor quality meat, the sheep gave no wool and only fat mutton. During the last hundred and fifty years, therefore, exotic breeds of both cattle and sheep have been introduced and cross-breeding undertaken. Today the wool and dairying industries are based on introduced breeds of sheep and cattle, but much of the mutton and beef comes from improved native stock.

Three things are of outstanding importance to the pastoral enterprises – climate, the nature and quality of the grazing, and the incidence of disease. South African stock farmers are fortunate in that winters are generally mild and only over the eastern plateau and southern Karoo, where temperatures below 32° F. may be experienced, are buildings for winter shelter necessary. But high summer temperatures are a drawback over much of the country, reducing sexual activity and restricting breeding, hampering the production of high quality meat, and

lowering the milk yields of dairy cows. The intense sunshine may also necessitate the provision of some shelter. The most serious limitations, however, are imposed by the low, unreliable, and poorly distributed rainfall, which adversely affects the nature and quality of the grazing and creates problems over supplies of drinking water.

Everywhere the carrying capacity of the veld is low (Fig. 78). Moreover, its quality varies regionally and seasonally. The summer rainfall grasslands provide

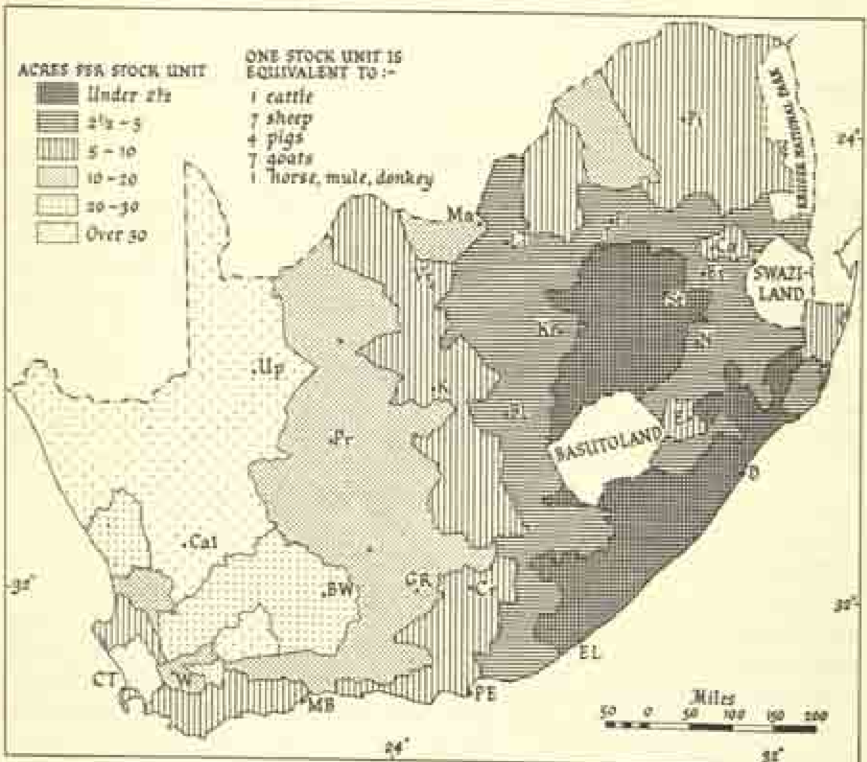
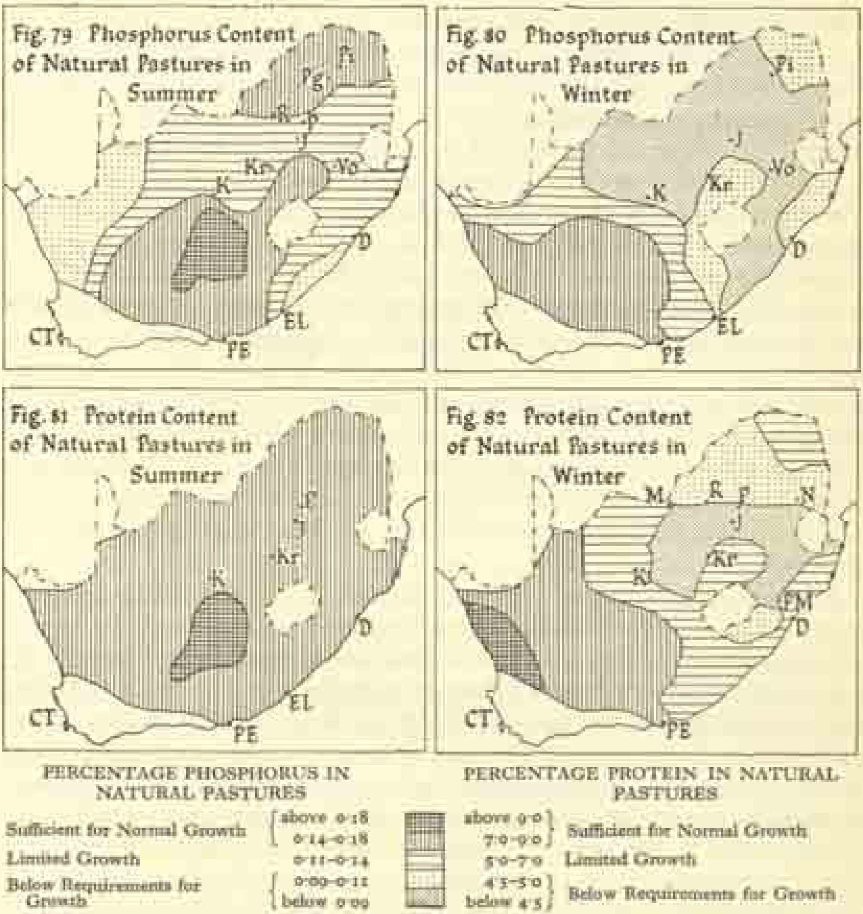


Fig. 78. The livestock carrying capacity of the natural veld.

nutritious grazing for a variable period from November to May but, with drought and frost, the grasses die down in winter and become harsh and unpalatable. The grasses of the warmer drier savanna areas remain sweet during the dry season but can support fewer stock. The Karoo bushes are remarkably resistant to drought and retain their nutritive properties throughout the year. Generally speaking, they have a higher phosphorus and crude protein content but provide less food per unit area than grasses. Over much of the country, however, the grazing is low in protein and deficient in phosphorus (Figs. 79–82),[1, 2] this being due mainly to the lack of phosphates in the soil. The phosphorus deficiency has been associated with

diseases in stock,[3] actually causing 'styfziekte' (stiff sickness) and in addition producing a depraved appetite which has made the animals eat rotten bones infected with the causal bacteria of 'lamziekte' (paralysis) which usually results in death. These diseases are most common on the drier grassland areas extending from the western Transvaal and Free State to the western Cape and South West



Figs. 79–82. The phosphorus and protein contents of the natural pastures.
(After P. J. du Toit, J. G. Louw and A. J. Malan.)

Africa, and also in the moister areas of the south-eastern Cape and the Natal Midlands. In the early days in the Cape it was customary to drive the flocks to graze around Saldanha Bay (where phosphate deposits underlie the surface) for limited periods each year in order to keep them healthy. Elsewhere heavy losses were frequent. Now that the causes of the ailments are known, they can be

avoided by giving top dressings of phosphatic fertilizer to the soil and feeding bone meal to the animals. Another ailment attributable to the grazing is 'geil-siekte' (gall sickness) which may occur during hot dry weather following good rains and is due to prussic acid poisoning caused by eating plants such as quick grass (*cynodon* spp.) and even good pasture grasses,[4] such as redgrass, which have become wilted. This danger can be avoided by inoculation or by the addition of a little sodium thiosulphate to drinking water.

The livestock enterprises are further handicapped by the prevalence of diseases caused by bacteria, viruses, and protozoa. The bacterial diseases common in most countries, including anthrax and contagious abortion, are present and among the virus diseases the dreaded foot-and-mouth disease and rinderpest. As in most advanced countries, the first two are controlled by inoculation and the sporadic outbreaks of foot-and-mouth disease are dealt with by slaughtering affected animals and isolating affected areas. The control of rinderpest[5] or cattle plague is more difficult as the disease is enzootic in wild game and domestic animals in Central and East Africa and threatens to spread southwards with movements of game. Co-operation between the neighbouring states of Southern Africa is essential for its control. To this end the central railway line of Tanganyika has been adopted as the southern limit beyond which the disease will not be allowed to spread. Since 1939 when the disease spread south of this line a game fence has been enforced along the northern boundary of Northern Rhodesia, a zone of immunized cattle established to the south, and a game intelligence service set up to watch game movements, the cost being borne by the Union and the Rhodesias.

At present the protozoan diseases transmitted by ticks[6] and the tsetse fly exert the most direct influence on livestock enterprises. In the coastal lowlands of Zululand and on the Lebombo Flats of Swaziland nagana and East Coast fever,[7] the former carried by the tsetse fly[8] and the latter by several species of tick, limit cattle rearing (see Fig. 83). East Coast fever can be controlled by dipping and by hand-dressing; nagana can be controlled by clearing the bush and spraying from aircraft to reduce tsetse fly infestation, but its eradication is difficult because it requires the destruction of the game hosts while domestic stock are not in the vicinity to act as new hosts. Such are the hazards attending cattle rearing in Zululand that, after the severe outbreak of nagana in 1946–7 which followed the destruction of game, the Union Government introduced a loan scheme for the purchase of tractors to enable farmers who had suffered heavy losses to go over to arable farming rather than re-stock their farms.

Apart from the East Coast fever, the most common tickborne diseases are redwater, heartwater and gall sickness, which are particularly rampant in the warmer areas, especially the Lowveld and Bushveld where imported breeds of cattle are particularly susceptible. The diseases may be controlled by regular and systematic dipping in solutions containing arsenic compounds, gammexane, or D.D.T.,[9] while stock can now be immunized against redwater by inoculation.

In the wetter areas it is necessary to inoculate sheep against 'blue tongue' disease and dose them for internal parasites which infest the veld in summer. Blowfly strike is a serious menace in most sheep-rearing areas.

While science is helping stock farmers to overcome the ravages of disease their most serious problem remains that of recurrent droughts. These have been recorded since the early days of European settlement but their impact has been more severe with sedentary settlement and heavier stocking of the veld. They afflict the better watered eastern areas as well as the drier west. During severe droughts stock can now be railed or trucked to better grazing but this is costly and even so losses may be heavy. The only solution to this problem is the growing of fodder crops to tide over drought periods and to this end the conservation of water for irrigation is to be encouraged where opportunities exist.

The distribution of cattle and sheep is influenced mainly by the character of the vegetation. The grasslands of the cooler and wetter parts of the country are used mainly for cattle grazing. Cattle rearing extends also into the hot arid country of the northern Cape where cattle are better able than sheep to endure the excessively high summer temperatures. Where the grass and thorn savanna gives way to desert shrub, however, sheep replace cattle and the Karoo is essentially sheep rearing country. Other livestock are kept in small numbers, their distribution being linked with arable farming and other economic factors, rather than with the physical environment.

Cattle

Until the end of the nineteenth century cattle were kept mainly for trek purposes and were mostly descended from indigenous stock. Dutch Friesians were introduced in the late eighteenth century and English Shorthorns and Devons were imported into the Eastern Province from 1820 onwards;[10] but little progress was made towards the establishment of dairying or beef production before the development of the Witwatersrand Goldfield created a large internal market. Shortly afterwards, in 1897, the herds were decimated by a severe outbreak of rinderpest, and further severe losses occurred during the Anglo-Boer war. The modern cattle enterprises, therefore, date from the beginning of the present century.

After the Anglo-Boer war the cattle population increased rapidly. In 1904 there were 3½ million head, and thereafter the numbers increased steadily to nearly 8 million in 1920, to 10½ million in 1930 and to nearly 12 million at the present day; of these nearly 7 million are owned by Europeans.[11] This increase in numbers has been matched by a considerable improvement in the quality of the animals, due to the introduction of European breeds and the improvement of the Africander (Plate 49), the breed evolved by the Boer settlers from Hottentot cattle. Beef production and dairying have become distinct enterprises. Yields and returns have been raised by the improvement of pastures and provision of feed. Since 1939 the number of animals slaughtered for meat has doubled, but whereas

before the war there was a small export, mostly of poor quality frozen meat to Italy and Belgium,[12] today the home market takes all the supply.[13] Dairying has shown a more spectacular growth. Apart from the great increase in fluid milk production, the butter output increased from 11 million lb. in 1910–11 to 30 million lb. in 1929–30 and 62 million lb. in 1951–2, and cheese from ½ million lb. to over 20 million lb. during the same period.[14] The home market takes most of the output, only about 3½ million lb. of butter and a little cheese being exported. The

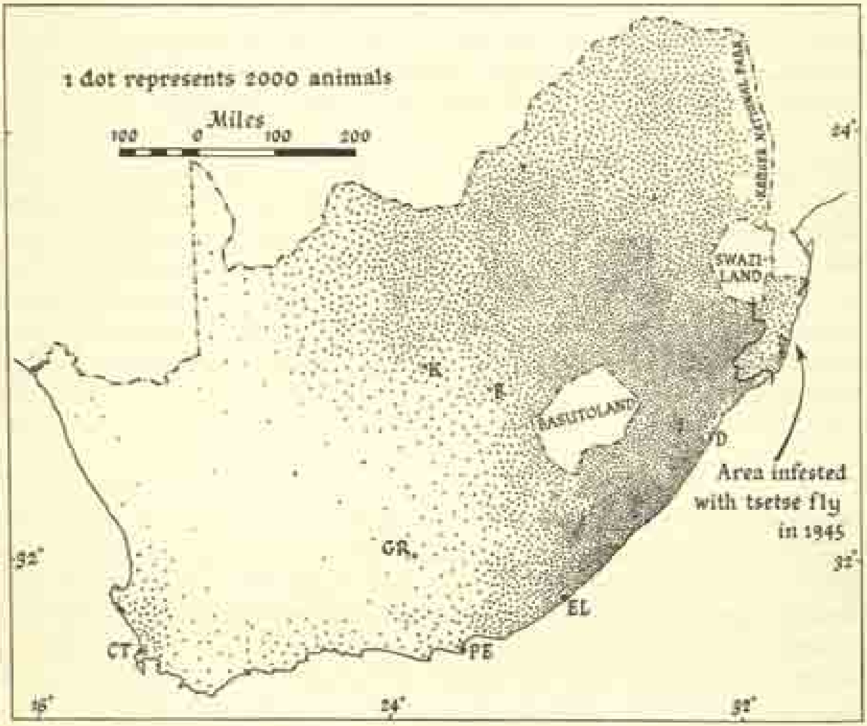


Fig. 83. The distribution of cattle.
Both European and Native owned (1949–50 census).

production of butter and cheese has also increased in South West Africa and Bechuanaland, everywhere being aided by the establishment of creameries and cheese factories which now process practically all the output.

The present distribution of cattle is related to the climate, the nature and quality of the grazing, and the incidence of disease. Generally speaking, cattle are found wherever the total rainfall exceeds 10 inches and grasses abound in the natural vegetation. Elsewhere, they are found only where exotic pastures have been established and fodder crops are grown with the aid of irrigation. The temperate grasslands of the plateau (Plate 49) and eastern uplands form the most

favourable areas and carry the densest cattle population (Fig. 83). Here both European and Africander types of cattle can be bred and reared successfully and both dairying and beef production are important. Nutritious natural grazing is available only during the summer months and hay, silage, and other supplementary feedstuffs must be given if milk yields are to be sustained and weight maintained during winter. The savanna areas of the Bushveld and Lowveld are also important cattle rearing areas. Here the natural vegetation provides sweet

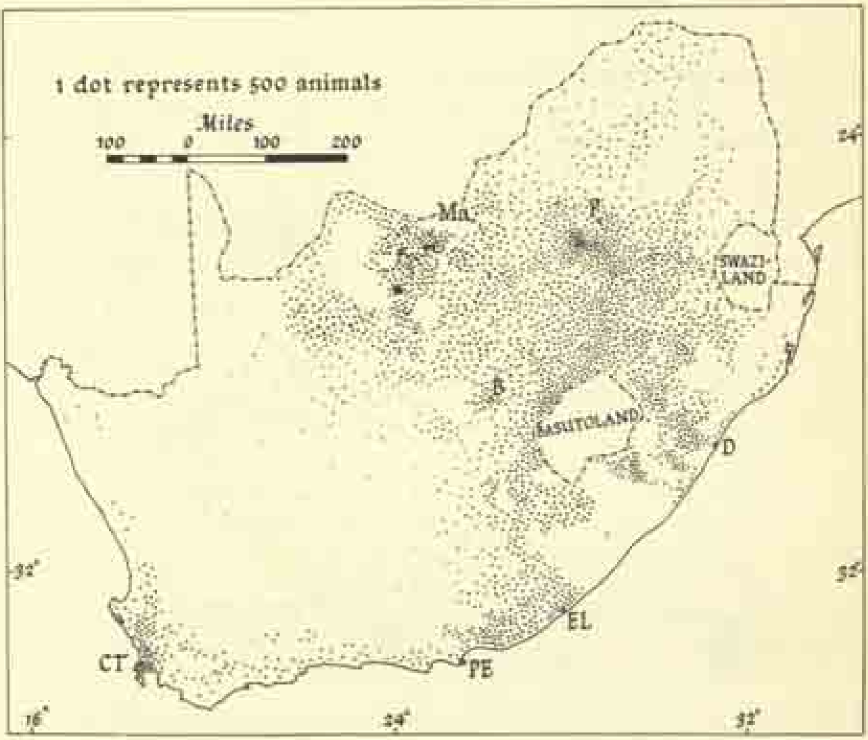


Fig. 84. The distribution of cows (2 years and over) kept mainly for milk production.

(1946–7 census.) European farms only.

grazing throughout the year, but owing to the high summer temperatures and prevalence of tickborne diseases, most European breeds of cattle do not thrive so that cattle enterprises depend on African stock. The Bushveld and Lowveld are therefore primarily stock rearing and beef producing regions, with dairy ranching of importance in the northern Cape thornveld. An outlying cattle rearing area occurs in the south-western Cape where, in the absence of natural grazing, reliance is placed on exotic pastures and fodder crops.

Dairying

Some measure of the importance of the dairying industry may be obtained from the fact that in 1951–2 the total value of dairy products exceeded £17 million, about one-third that of wool.

Two distinct types of dairying are carried on – intensive dairy farming, where the natural grazing is supplemented by hay, silage, and fodder crops, and dairy ranching dependent on the natural veld. Whether the emphasis is on fresh

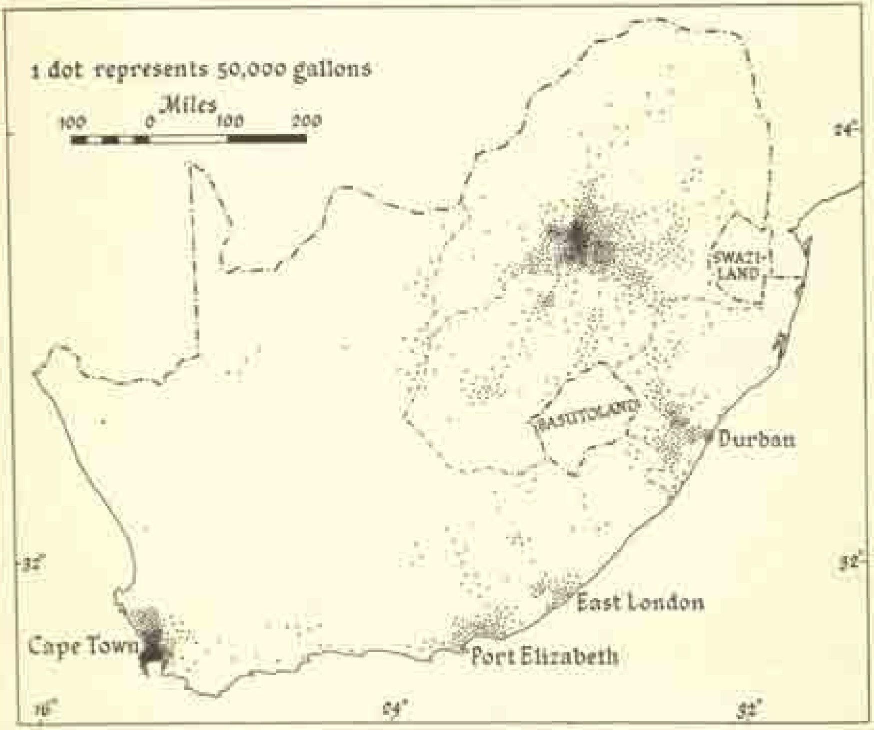


Fig. 85a. The distribution of milk production for the fluid milk trade. (1949–50 census.) European farms only.

milk, butter, or cheese depends mainly on transport facilities and access to markets.

The short or sweet grassveld areas of the Highveld constitute the best dairying areas for here temperatures seldom exceed 85° F. and there is nutritious natural grazing for about eight months of the year. As this is also the most favoured crop growing area, dairying is usually combined with arable farming. The sourveld or tall grassveld areas are less favourable owing to the rank growth of the grasses which become sour and unpalatable in late summer, thereby affording grazing for shorter periods. Here, as much of the land is of broken

relief, the soil frequently thin and infertile, and the growing season too short for grain production, stock farming is usually the sole concern. Elsewhere, either the climate is too hot or suitable natural pastures are lacking and where dairying is important it is supported by exotic pastures and fodder crops to meet the economic demand for fresh milk.

Everywhere fresh milk production[15, 16] is dependent on the demands of the big towns. On the Highveld, the producing areas are related to the facilities for

Fig. 85b. The distribution of milk production for the processing factories. (1949–50 census). European farms only.

reaching the Witwatersrand market, and extend in a tentacle-like fashion along all the routeways radiating out from Johannesburg to Breyton, Durban, Bloemfontein and Ladybrand (Fig. 86). Near Johannesburg, the farms are comparatively small, some merely providing exercising grounds for the animals, and lucerne, hay, maize meal, and oilcake concentrates have to be bought. South-eastwards in the maize belt, dairy farms average about 1,400 acres and milk production is combined with grain production; here maize provides the basic feed, cowpeas and soya beans are grown for fodder, and teff for hay while pastures of clover, rye-grass, Rhodes grass, and setaria have been established. Near the Escarpment,

where the generally cool summers and prevalence of mist virtually exclude grain crops, nearly 80 per cent of the land is used for grazing, but pastures of ryegrass, Rhodes grass, and paspalums have been established for the dairy herds, and beans, kale, and turnips are grown for fodder.

Fresh milk producing areas are found also near the ports (Fig. 85a) in areas

Fig. 86. The Johannesburg milkshed (1950).

where good natural grazing is absent. Near East London the herds graze the sourveld in early summer, while lucerne, sunnhemp, velvet beans, and the leguminous vine *Glycine javanica* are grown mainly for silage, the summer rains hampering haymaking. Behind Port Elizabeth the natural bush is unsuitable for dairy cattle, but in the Sundays river valley, lucerne grown under irrigation supports a dairying industry which provides the port with fresh milk. Cape Town draws its supplies from the Cape Flats and the Swartland. In the former, the

dairy farms (Plates 106 and 107) are largely dependent on purchased feedstuffs; in the Swartland, lucerne, grown in rotation with wheat on the drylands, and exotic pastures of ryegrass and clover established both in the cool kloofs and on irrigable land provide grazing and yield hay in an area devoid of natural grazing.

In all these areas the herds are almost all of Friesian stock (Plate 50), but some farmers, giving particular attention to the quality of their pastures and to the production of feedstuffs, keep Jersey herds.

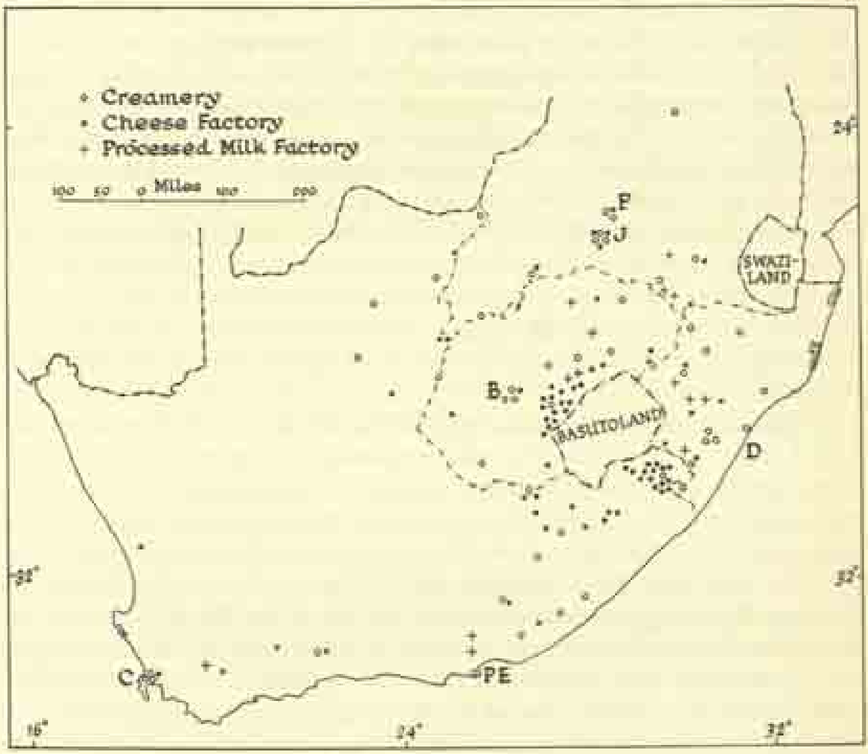


Fig. 87. The distribution of milk processing factories.

The butter and cheese producing areas are beyond the range of the big urban markets, and depend very much on local creameries (Fig. 87). The first factories were actually established, in the late nineteenth century, near Bedford in the eastern Cape and were followed by others in Natal and later in the Transvaal.[17] The factory production of butter and cheese was stimulated by the invention of cream separators and the introduction of refrigeration, but until 1933 progress was hampered by the seasonal flow of milk (consequent upon variations in the grazing), which led farmers to withhold their supplies from the factories and produce farm butter and cheese in the scarce winter season in retaliation for

exploitation by the factories in the flush summer months. Prices were not stabilized until the establishment in 1933 of the Dairy Producers Selling Agency, whose functions were taken over by the Dairy Industry Control Board, a government body, in 1940.[18] Since then the output of butter and cheese has steadily increased (see Fig. 158) despite the increasing diversion of milk to the fresh milk trade. Butter and cheese production has been pushed into the more remote areas, where the emphasis is on butter production in the drier areas where the cows give relatively smaller quantities of milk rich in butter-fat and on cheese in the better watered areas where the yield is higher but the butter-fat content less. Thus today the Caledon river area of the Free State, the northern Cape, and the Transvaal each account for about one-quarter of the butter output, while the first two mentioned and the eastern Cape provide 75 per cent of the cheese output. Natal and East Griqualand, formerly important producers, now supply the fresh milk trade. Recently pasteurization has made possible the spectacular development of dairy ranching in the northern Cape, northern Transvaal, and Bechuanaland. Here the animals are milked only when they come in to drink, usually only once a day, and yields are low, but the total output is considerable. The cows are mainly Africander, well able to withstand the high temperatures and utilize the scanty grazing. Elsewhere the cows are milked regularly, but all too frequently are left to forage on unimproved veld and are rarely provided with hay and silage during the winter months.

Despite the progress made dairying still labours under difficulties occasioned by the physical environment. Summer temperatures are generally high and may exceed the critical point for sustained milk yields. The grazing is less nutritious than in the dairy belts of north-west Europe, the U.S.A., and New Zealand, being deficient in phosphates and protein and of low digestibility; only during a short period of six or eight weeks during the period of active growth following the first spring rains do they provide adequate feed for high producing dairy cows. In the better watered areas concentrates, particularly maize silage, are readily available and cheap; elsewhere supplementary feedstuffs present a serious problem. Moreover the low carrying capacity of the veld means that long distances have to be covered between the pastures and the milking stables, drinking water is often short, and high temperatures restrict grazing to the cooler part of the day. These conditions adversely affect European breeds which form the backbone of the industry, the indigenous cattle being poor milkers. Friesians do best and are most widely kept. Jerseys thrive only where plentiful rich feed is available from irrigable land, while dual-purpose Shorthorns are popular in the eastern Cape. Yields are invariably lower than in Europe, while the content of butter-fat is slightly lower and that of solids-not-fat, especially protein, markedly lower.[19, 20, 21] In the wetter parts of the country there is little doubt that milk output could be considerably increased on many farms by the keeping of better stock and increased attention to pasture improvement and the production of supplementary feedstuffs. Since 1935 State-aided milk and butter schemes have helped the

industry and diverted as much as possible of the produce to the home market. National butter production, however, averages only 60 million lb., whereas the National Nutritional Council estimates the needs at 350 million lb. Partly because of this shortfall and partly because of the high cost of butter, the Government, in face of stiff opposition from the farmers, has permitted the manufacture of margarine for supply to people in lower income groups.

Cattle Rearing and Beef Production

Cattle rearing is traditionally a pioneer activity and with the extension of crop production and of dairying in the better watered parts of South Africa, it has tended to move into the hot, drier, and less healthy Bushveld and Lowveld and into the inaccessible hilly country of the Drakensberg. At the same time, since 1939, the mechanization of agricultural operations, and the consequent diminution in the need for trek oxen, has provided new opportunities for beef production on the Springbok Flats, where young steers can be fattened on maize stalks, peanut hay, silage, and fodder crops in autumn.

One might expect the Bushveld and Lowveld to concentrate on rearing stock for fattening on the Highveld. This, however, is not possible because the English breeds which thrive on the Highveld are unsuited to the Bushveld and Lowveld where they are prone to tickborne diseases and are unable to maintain normal metabolism in the hot summers when furthermore the bulls tend to infertility. Here cattle enterprises depend on the Africander,[22] whose thick skin and high hair density enable it to maintain a lower body temperature and to remain fertile in hot weather, and give it a greater resistance to tickborne diseases. Both on the Highveld and in the low country the farmers therefore rear and fatten their own stock. Near the Witwatersrand, however, some farmers fatten stock purchased from the northern Free State and the Basutoland border.

On the Highveld, beef fattening is usually combined with maize production. Here, there is an increasing number of Hereford, Aberdeen Angus, and high quality Africander and cross-bred herds, which are fed veld hay, maize silage, and other fodder crops in winter but there are still many scrub cattle which are left to graze the ordinary veld in winter, thereby losing weight and yielding poor quality meat on slaughter.

In the low country cattle rearing is still largely of a pioneer nature. In the north-western Transvaal stock rearing on farms averaging around 6,000 acres is a recent development; as yet little fodder is grown and most of the animals are fattened on the Springbok Flats or near the Rand, but along the Limpopo river a series of small dams for watering stock and irrigating fodder crops is planned. Given adequate water, Napier Fodder, the setarias, paspalums, pennisetums and babala yield large quantities of hay and silage in this region. In the Transvaal Lowveld some steers are fattened where fodder grasses are grown under irrigation along the Crocodile valley, but most cattle raised in this region have to depend entirely on the natural grazing.

In the low country herds consist mainly of scrub cattle of poor quality, but attempts are now being made to breed a beef type of Africander for these regions. In addition it has been found that certain British breeds have a higher heat tolerance than others and it is hoped that by cross-breeding with animals carefully selected for their ability to maintain normal metabolism at high temperatures, it may be possible to combine the superior beef qualities of the exotic breeds with the natural resistance of the native stock. In this way it may eventually be possible to evolve an animal which can be reared in the low country and transferred to the Highveld arable belt for fattening.

Meanwhile the production of good quality beef is still handicapped by the traditional breeding of cattle for draught purposes while heat, drought, and poor grazing mitigate against rapid growth and flesh development.[23] Much has been accomplished of recent years as a result of breeding, better veld management, and the production of fodder crops but it is doubtful whether the production of baby beef, for which a continuously high level of nutrition is required, will ever be economic. The slower maturing types produced from crossing Africanders with British beef breeds seem better adapted to the South African conditions, and suffer less from periodic shortages of food.[24]

The rearing of stud cattle for both beef and dairy herds is restricted mainly to the higher ground near the Drakensberg, particularly in the eastern Free State, the midlands of Natal, and the south-eastern Cape, where the temperatures, averaging between 45° and 65° F., resemble those in the overseas areas in which the breeds have been developed by constant selection, and the higher rainfall permits the establishment of good pasture and ensures the provision of adequate fodder. Herefords are bred mainly around Standerton, Aberdeen Angus near Nottingham Road, and Shorthorns in the eastern Cape.

Sheep

The importance of sheep in South Africa is best measured from the fact that every year, by value, wool is second only to gold among the Union's exports. Sufficient mutton is produced for home needs but there is no export.

The early Dutch pioneers moving northwards into the arid interior of the Cape built up flocks of fat-tailed, non-woolled sheep[25] from animals bartered from the Hottentots but the development of the South African sheep rearing industry really dates from the occupation of the southern coastal belt and the introduction of merino sheep in 1789. Subsequently from 1820 onwards, various English breeds were introduced but the merino proved most successful.[26] As the European settlers moved northwards from the south-eastern Cape into the eastern Karoo the woolled sheep population increased rapidly, overtaking that of non-woolled sheep by 1850 and exceeding it fourfold by the end of the century. Nevertheless by world standards South Africa remained a comparatively small wool producer. After Union, however, aided by the introduction of Australian merinos, wool production made such rapid progress that by 1925 South Africa

had become the fourth wool producer in the world and the second largest producer of fine wool.

Wool production actually reached its peak in 1932–3 when over 300 million lb. were produced. Low world prices during the Great Depression, however, led many farmers in the better watered parts of the Cape to reduce their flocks and plough up their land for wheat, which found a ready sale at guaranteed prices on the home market, while others in the Transvaal turned over to cattle. As a result the woolled sheep population fell from 40 million in 1929 to 32 million in 1939 and 24 million in 1946. Since the war, however, wool prices have been remarkably high. Whereas the 1938 clip of 240 million lb. fetched only £9 million, the 1950 clip of about 200 million lb. fetched £40 million and that of 1951, which was slightly smaller, over £90 million. Since 1946 the high prices have stimulated some increase in the woolled sheep population, numbers rising to nearly 26 million in 1950 and to over 31 million in 1953, but it is unlikely that they will again approach the 1929 level.

While the woolled sheep population has been declining the number of non-woolled sheep, has been increasing although there are still only about 4½ million. Most of these are fat-tailed, fat-rumped breeds, mainly Blackhead Persian and Africander. In South West Africa there are about 3 million Karakuls, which are kept also in adjacent parts of the Union. In addition there are some English mutton breeds as well as small numbers of German merinos, and other European breeds.

The distribution of woolled (Fig. 88) and of non-woolled sheep (Fig. 89)[27] is in each case closely related to the physical environment. The greatest density of woolled sheep, nearly all merinos, is found in the south-eastern Cape and the adjoining parts of the Orange Free State where sweet grassveld and Karoo bush afford year-long grazing. Westwards the numbers decrease with the reduced carrying capacity of the veld consequent on the lower rainfall. Woolled sheep are important also on the short grasslands of the eastern Highveld and in the south-western Cape. They are absent from the savanna areas of the Transvaal and Natal and are unimportant in the northern Cape. In the last mentioned area, where the rainfall is less than 8 inches and average temperature maxima exceed 90° F., the merinos not only find the scanty grazing inadequate but have difficulty in getting rid of excess heat. Here they are replaced by non-woolled types (see Fig. 90) which are found also in smaller numbers in the Karoo and in the savanna areas.

The non-woolled sheep, other than Karakuls, are reared solely for mutton. The merino sheep are reared primarily for wool but in some parts of the country are regarded as a dual-purpose breed and are crossed with English mutton breeds for fat lamb production.

The most important wool producing area is in the eastern and central Cape, where the rearing of merino sheep[28] is usually the sole interest of most farmers. The best quality wool is produced where the rainfall averages 12 to 15 inches annually and where the level of nutrition is uniform throughout the year. Wool yields

average 9–10 lb. per head on the sweet grassveld around Barkly East, Somerset East, and Graaff-Reinet which supports one sheep to the morgen; on the Karoo veld, they are slightly higher at around 10 lb. per head, but the carrying capacity of the veld is less, one sheep requiring 1½ morgen in the east and 4 or 5 morgen in the west where the rainfall averages only 8 inches. In the drier areas the sheep expend so much energy in the search for food that growth is retarded and their fleece yields only 7–8 lb. per head.

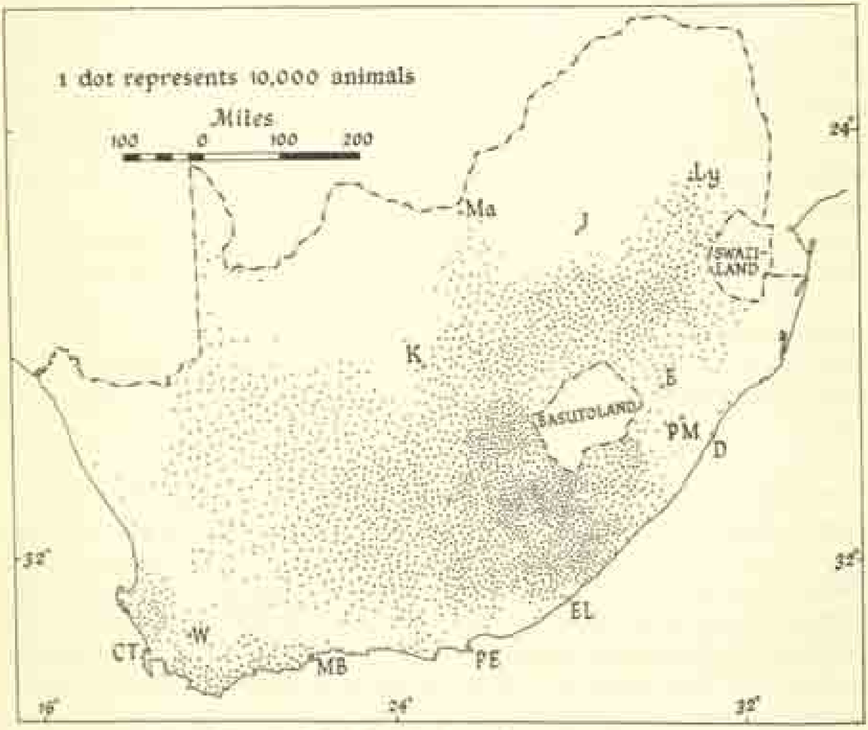


Fig. 88. The distribution of woolled sheep.
(1949–50 census.) Both European and Native owned.

On the eastern Highveld merinos are kept for both wool and mutton production. Here the sourveld provides fairly good grazing during the summer months but affords little sustenance in late autumn and winter.[28] Formerly, as the grasses became sour and unpalatable in autumn, it was customary for the farmers to trek the ewes to the sweet grazing of the Middleveld for the winter months. Here they burnt the vegetation to provide young growth for their stock, a practice which also kept down diseases and parasites. Here lambing normally took place. At the end of winter as the Middleveld became too hot and the grazing less suitable for sheep, the trek back to the Highveld began, arriving in time for the new grass of

early summer. Trekking is still practised in the south-eastern Transvaal where some farmers own or rent grazing land in the Swaziland Middleveld and regularly fire the veld on the Barberton Mountain Land. But the division of farms and closer settlement have considerably curtailed the movement and have necessitated a change of economy and a more intensive land use. More than anything else these changes have caused the reduction in the merino flocks which has been most marked in this region. Unlike cattle, sheep cannot be maintained in good

Fig. 89. The distribution of non-woolled sheep.
(1949–50 census.) Both European and Native owned.

condition during the winter on veld hay, and with supplementary feed cross-bred sheep for mutton and fat-lamb production and cattle enterprises are more profitable.

Merino numbers have declined also, however, on the eastern Cape sweetveld and in the Karoo where their highly selective grazing habits have contributed to the deterioration of the veld. The reduction has been hastened by the low fertility and poor milk yields of the merino ewes, caused very largely by overbreeding for wool.[29]

The production of mutton and lamb has been and is still handicapped by

unfavourable geographical conditions and also by the overwhelming importance of wool. The natural veld is nowhere sufficiently nutritious for fattening, which can be undertaken only in the crop producing areas as part of a mixed economy or where irrigation enables fodder crops to be grown in the arid regions. Until recently, due to the overriding importance of wool, merino sheep have dominated activities. But they do not yield a good mutton carcase, and since the ewes have a low fertility level and produce only small lambs for which they have little milk,

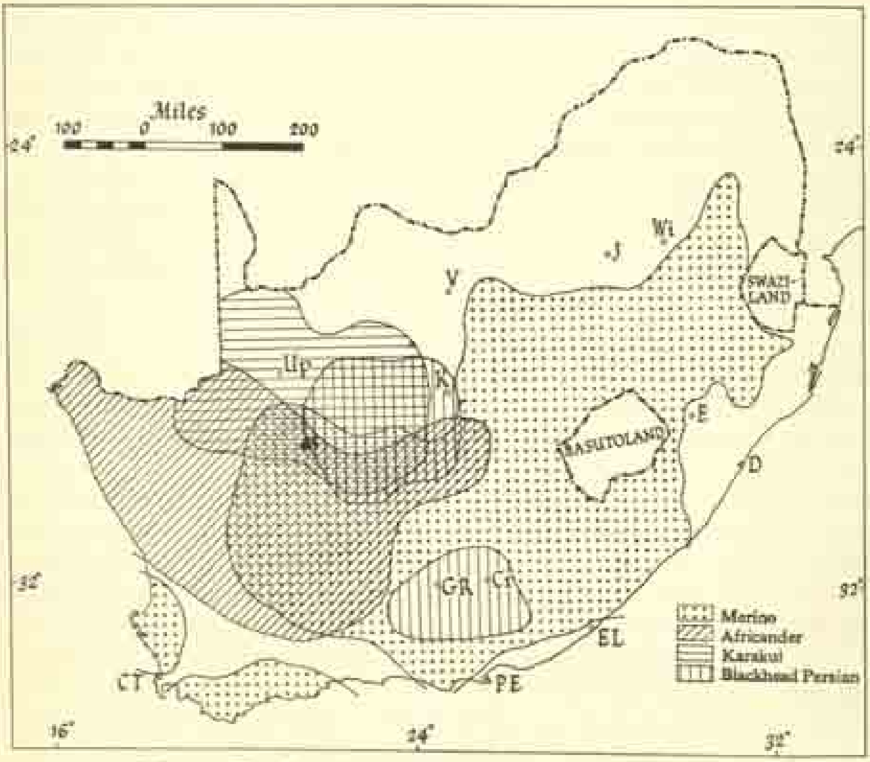


Fig. 90. The distribution of the leading breeds of sheep.

they are unsuitable for fat lamb production. The Blackhead Persian,[31] a North African breed introduced in 1868 from a sailing ship wrecked near Swellendam, and the Africander, descended from Hottentot stock, are considered better mutton sheep than the merino but judged by English standards their meat is of poor quality. Recognized British and other European mutton breeds produce far superior meat but generally speaking they thrive only in the cooler parts of South Africa and require better feed than merinos and Persians.[32] In all parts of South Africa the development of mutton and fat lamb production depends on the success of crossing merinos or Persians with recognized European mutton breeds

and on the provision of supplementary feeding. In both directions some progress has been made in recent years.

In the Karoo interest naturally centres on merinos for wool, and fat lamb[33] production is possible only as a side line where flood irrigation permits the growing of cereals and lucerne for supplementary feed. The breeding of lambs for fattening in the irrigable valleys and the rearing of cross-bred ewes for breeding stock in the meat producing areas, however, may be quite important. Because of the necessity of maintaining the high quality of the wool only such breeds as Romney Marsh, Border Leicester, Dorset Horn, and Ryeland, which have a pure white fleece, may be used for crossing with the merinos. On the irrigation schemes in the Sundays and Great Fish river valleys the farms are usually too small – 30 to 300 morgen – and the land too valuable for the maintenance of large permanent flocks. On the larger farms possessing some unirrigable veld, small flocks of cross-bred ewes and rams of English mutton breeds are kept for breeding and the lambs are sold off as soon as they are ready. On others lambs are purchased from the Karoo and fattened on lucerne for slaughter in Port Elizabeth. In the Orange Free State fat-lamb production has become important along the Riet and Kaffir rivers since the completion of irrigation dams has provided opportunities for the growing of lucerne and other fodder crops. Along the Caledon river and in the eastern Free State autumn rains permit the growing of winter wheat in favourable years. Late frosts make grain production hazardous but the crop eaten off green provides excellent grazing for lambing ewes and supports fat-lamb production. For the drier parts of the Karoo, the Dorper, a Dorset Horn–Persian cross, appears promising for mutton and lamb production.[34] Able to tolerate the severe conditions, it yields better quality mutton than the Persian; it has the high fertility of the latter but the ewe produces about three times as much milk so that the cross-bred lamb matures earlier, giving a market weight of 65–70 lb. in 5–6 months under favourable circumstances.

In the south-western Cape sheep rearing is governed by the scarcity of natural grazing and dependence on the volunteer grasses which take possession of the old cultivated lands in winter, supplemented by green oats grazing in autumn and stubble after harvest. Feed is scarce towards the end of the hot dry summers. The lighter merino ewes are best able to endure the season of scarcity and wool production has long been the main concern here. Recently, however, some attention has been given to fat-lamb production for which there is adequate feed in winter. Autumn lambing is essential and for this reason merinos are again best suited to the area, being mated with German merinos and Dorset Horns. Recently cross-breeding has produced the 'Dormer' (German Merino × Dorset Horn) which appears well suited to fat-lamb production in this area.

In the Cape coastal belt and in the higher parts of Natal and the Transvaal, where the rainfall is higher and more evenly distributed, sheep rearing, and particularly fat-lamb production, is handicapped by the prevalence of parasites and diseases like 'blue-tongue' and 'geilsiekte'. The rich summer pastures of the

eastern grasslands are full of the eggs of these parasites so that spring-born lambs become infested with tapeworm, wireworm, nodular worm, and a host of other parasites by the end of summer. Autumn-born lambs, on the other hand, arrive when the veld is healthier but its nutritive value is becoming low.[35, 36] For autumn born lambs winter feeding is therefore essential. Further difficulties arise from the fact that spring is the normal lambing season for merino ewes. The solution would appear to be in cross-breeding. But whereas merino ewes survive the attacks of parasites the mortality among English mutton breeds, and particularly among rams, is high. By crossing the South African merino with the heavier German merino, which is a good mutton breed, however, a new merino strain has recently been developed at Dohne experimental station.[37] This promises to be a good dual purpose animal for the sourveld; for the ewes have a high fertility and lamb both in autumn and spring; and the lambs, benefiting from the ewes' greater milk supply, attain a weight of 50–60 lb. at 5 months and 80–120 lb. at 10 months; and although the wool is of slightly poorer quality the yield is higher than that of the South African merino. The strain also appears to be relatively resistant to the various diseases.

In South West Africa and the adjoining parts of the Union, Karakul sheep are of outstanding importance. Natives of Turkestan they were originally introduced into South West Africa by the Germans. Since 1945 their numbers have increased markedly in the Union. Karakuls are kept for the glossy black tightly curled pelts of the new-born lambs, valued by furriers. Since the lambs must be slaughtered before the curls unroll, usually within 48 hours of birth, only the breeding stock has to be maintained through the year; and as the breed flourishes under semi-arid conditions, Karakul farming is very profitable even in areas receiving less than 5 inches of rainfall. In South West Africa about 2½ million pelts are exported yearly and, bringing in about £5½ million, are easily the most valuable export. In the Union about ½ million pelts are produced each year. Here the industry does not receive any official encouragement as it supplies a luxury market subject to wide fluctuations of price whereas wool production is of overwhelming importance to the country's economy.

Other Livestock

Apart from poultry other livestock enterprises are relatively unimportant. Horses of Persian-Arabian origin were imported from the East Indies soon after the first settlement and were followed by others from Persia; from these the famous Cape horse, renowned for its strength and endurance, was bred and gave rise to a lucrative trade in remounts for the Indian army.[38] After 1795 English thoroughbreds were introduced while the breeding of fine horses increased as the eastern grasslands were occupied during the nineteenth century; during this period horses captured by the Bantu provided the foundation stock for the now famous Basutoland pony. At the beginning of the nineteenth century horses were exported to Australia where they laid the foundation of the breeding industry which

by 1860 had captured the Indian remount trade. Meanwhile from 1854 onwards severe outbreaks of an epizootic disease, 'Horse sickness', killed large numbers, the Cape farmers went over to sheep and ostriches, and the coming of the railways after the discovery of mineral wealth killed the transport riding trade and with it the demand for horses. During the present century the motor-car has completely superseded horse transport except in Basutoland where the country is mountainous and there are few roads. The number of horses had fallen steadily until today there are only 300,000 owned by Europeans in the country.

Horses have never been used for ploughing and cultivating the land; oxen, mules and donkeys have performed these functions. Today there are only about 90,000 mules and 300,000 donkeys on European farms, mainly in the grain belts of the Transvaal and Free State. However, their numbers have decreased in face of increased mechanization, a trend likely to continue.

Pigs are indigenous to South Africa but they have never been domesticated and those reared for pork and bacon are descended from animals imported from Europe.[20] A few pigs were kept by the early settlers in the south-west Cape and also by the 1820 settlers in the south-eastern Cape but largely because pigs do not lend themselves to pioneer conditions their numbers remained small until the present century. Even today despite favourable climatic conditions, the absence of diseases and large-scale maize production there are only about 700,000. This represents an increase of 30 per cent since 1930, and now with closer settlement and more intensive farming pigs are becoming more important. They are kept mainly in the grain areas of the south-west Cape, the Highveld, and the Springbok Flats where feed is plentiful and around Estcourt, where processing factories have been established near the main Johannesburg–Durban railway. The main object is the production of lean pork and bacon, there being no demand for the lard type in such a warm climate. There is some export of bacon, ham, and canned sausages.

The poultry industry has similarly made strides during the present century, and now provides surplus eggs for export. Since the plentiful season in South Africa coincides with one of scarcity in Europe there is a ready market; since the war an average of about 80,000 cases of 30 dozen each have been exported to England annually. The industry is widely distributed but shows some concentration in the grain belts and near the towns where there is a market for table birds as well as for eggs. Recently turkey breeding has increased and already the supply exceeds the demand so that its future depends on an export trade. Generally speaking the conditions are favourable for the poultry industry, which with closer settlement is likely to increase provided export markets can be found for the produce.

Since the first world war there has been a continuous reduction in the number of goats kept by Europeans, due to the increase in other stock enterprises, the limited market for the products, and the disrepute of the animal as an initiator of erosion. At the beginning of the century South Africa was a very important

producer of mohair derived from the Angora goat, which had been introduced in 1838 and had become widely distributed in the drier areas. The output reached a peak in 1912 when over 23 million lb. were produced from over 4 million animals. Today there are less than ½ million animals yielding only 4 million lb. of mohair. With the extension of jackal proof fencing, the angora has given way to the more profitable merino sheep and remains important only in the dry Karoo of the south-eastern Cape. The number of South African goats has similarly decreased steadily from over 7 million in 1912 to 1 million in 1950 and today they are found only in the arid north-west Cape and in the rough hilly bush country of the northern Transvaal where other stock do not thrive.

Ostrich farming is no longer important, having collapsed with the change of fashion during the first world war. Today there are only 50,000 birds, compared with the ¾ million in 1913. They are kept mainly around Oudtshoorn in the Little Karoo and in the Sundays river valley (Plate 52) where the hot dry climatic conditions favour the rearing of the birds and the development of fine feathers and lucerne may be grown under irrigation for feed.

BIBLIOGRAPHY

1. P. J. du TOIT, J. G. LOUW, and A. I. MALAN. 'A study of the mineral content and feeding values of natural pastures in the Union of South Africa'. *Onderstepoort J. Vet. Sc. and Anim. Husb.*, Vol. XIV, 1940.
2. SIR A. THEILER, H. H. GREEN, and P. J. du TOIT. 'Phosphorus in the livestock industry'. *S.A. Dept Agric. J.*, 1924.
3. M. W. HENNING. *Animal Diseases in South Africa*, VOLS I and II. Central News Agency. Johannesburg. 1932.
4. T. D. HALL. 'South African pastures, retrospective and prospective'. *S.A. J. Sc.*, Vol. XXI, 1934.
5. R. A. ALEXANDER. 'A brief review of Rinderpest in Africa'. *F. in S.A.*, Vol. XXIII, 1947.
6. R. du TOIT. 'Ticks and tick-borne diseases'. *F. in S.A.*, Vol. XVIII, 1942.
7. W. O. NEITZ. 'Studies on East Coast fever'. *S.A. Sc.*, Vol. I, No. 7, 1948.
8. G. de KOCK, R. du TOIT, and E. B. KLUGE. 'Die tsetsevlieg probleem van Suidlike Afrika'. *S.A. Sc.*, Vol. I, No. 1, 1947.
9. P. M. BEKKER and H. GRAF. 'Gammexane and D.D.T. dips for control of arsenic-resistant Blue Tick'. *F. in S.A.*, Vol. XXII, 1946.
10. H. P. D. van WYK. 'The imported cattle breeds'. *F. in S.A.*, Vol. XXVII, 1952.
11. Agricultural Census reports.
12. Official Yearbook of the Union of South Africa, No. 18, 1937.
13. Official Yearbook of the Union of South Africa, No. 21, 1940.
14. Annual report of the Department of Agriculture in *F. in S.A.*, Vol. XXVIII, 1952.

15. F. R. TOMLINSON and A. R. HAVEMANN. *Economic Studies in Milk Production.* S.A. Dept Agric., Bull. No. 239, Econ. Ser. 33, 1941–2.
16. F. R. TOMLINSON. *Study of Fresh Milk Farming in Natal, 1947–8.* S.A. Dept Agric., Bull. No. 314, 1951.
17. C. W. ABBOTT. *A History of Butter Making in South Africa.* S.A. Dept Agric., Bull. No. 300, 1949.
18. National Marketing Council, Report No. 66. *Dairy Production Costs and Prices.* Pretoria. 1946.
19. E. J. PULLINGER. 'The chemical composition of milk produced on the South African Highveld for supplying the fluid milk trade'. *J. S. Afr. Vet. Med. Ass.*, Vol. XVIII, No. 4, 1946.
20. S. BAKALOR. 'Investigations on the composition of South African milk'. *F. in S.A.*, Vol. XXIII, 1948.
21. F. N. BONSMA. *The Influence of Environmental Factors on the Age Correlation Factors for Milk Yield of Friesland Cows in South Africa.* S.C. Dept Agric., Bull. No. 242, 1943.
22. J. C. BONSMA. 'The Afrikander. Relation between conformation, function and adaptation'. *F. in S.A.*, Vol. XXV, 1949.
23. F. N. BONSMA and R. HERSEL. *Factors Determining Quality in Beef.* S.A. Dept Agric., Pamph. No. 226, 1941.
24. J. C. BONSMA. *The Influence of Climatological Factors on Cattle.* S.A. Dept Agric., Pamph. No. 223, 1940.
25. J. S. STARKE. 'The development of the non-woolled sheep'. *F. in S.A.*, Vol. XXVIII, 1952.
26. J. C. de KLERK and S. W. BOSMAN. 'Merino sheep farming in South Africa'. *F. in S.A.*, Vol. XXVIII, 1952.
27. J. S. STARKE. 'The different kinds of sheep'. *F. in S.A.*, Vol. XXVI, 1950.
28. J. J. J. KOTZE. 'The merino and its environment'. *F. in S.A.*, Vol. XIV, 1939.
29. J. P. BOTHA. 'Veld management in the eastern Transvaal'. *F. in S.A.*, Vol. XXI, 1945.
30. W. J. HUGO. 'Is the merino losing?'. *F. in S.A.*, Vol. XXV, 1949.
31. F. J. LABUSCHAGNE. 'The Blackhead Persian'. *F. in S.A.*, Vol. XXIII, 1948.
32. G. W. JOHNSTON. 'English sheep under South African conditions'. *F. in S.A.*, Vol. X, 1934.
33. D. C. MAREE, P. J. JOUBERT, H. C. BONSMA, and L. H. BARTEL. *Fat-lamb Production in the Union.* S.A. Dept Agric., Pamph. No. 204, 1939.
34. W. D. MEYER. 'The development of mutton sheep in the Union'. *F. in S.A.*, Vol. XVI, 1950.
35. J. C. de KLERK. 'Summer lambing versus winter lambing'. *F. in S.A.*, Vol. XVI, 1940.
36. J. J. KOTZE. 'Fat-lamb production in the sourveld area'. *F. in S.A.*, Vol. XXVI, 1950.

37. F. W., 2 Feb. 1949.
38. D. BUYSKES. 'Origin of the South African horse'. *F. in S.A.*, Vol. XXVII, 1952.
39. F. N. BONSMA and D. M. JOUBERT. 'Pig farming in South Africa'. *F. in S.A.*, Vol. XXVII, 1952.

14

Soil Erosion, Veld Management, and Conservation Farming

Until very recently pastoral activities in South Africa had, for centuries, been attended by a number of practices – notably veld burning (Plate 53), overgrazing, and kraaling – leading to the impoverishment of the vegetation, soil deterioration, and soil erosion (Plates 54 and 55). In this South Africa was by no means unique, these practices and their inevitable consequences being common wherever ranching is carried on under pioneer conditions.[1] In the period between the two world wars South Africa passed through the phase of extensive grain cultivation, maize on the Highveld, wheat in the south-western Cape. In the latter region the ploughing of steep slopes and in both regions continuous monoculture, non-use of fertilizers, and exposure of the bare ground after harvest, brought about alarming sheet and gully erosion.[2] Before the second world war, South Africa had achieved the unenviable distinction of being the most severely eroded country in the world and the one in which soil erosion and soil deterioration were most nearly approaching the stage of national disaster.

It is easy to condemn the malpractices of the past but it should be appreciated that, on the one hand, over much of South Africa the physical environment is highly conducive to soil erosion and, on the other, economic circumstances gave little alternative to the stock farmers or to the grain farmers, who, in any case, did not foresee the evils they were initiating.

Much of South Africa is for one reason or another highly susceptible to erosion. The steep slopes near the plateau edge and the Cape mountains are prone to erosion. Here and also over the level plateau rainfall of high intensity activates erosion. In the Karoo and semi-desert areas an incomplete vegetative cover leaves the ground exposed to erosion. And everywhere any disturbance of the vegetative cover, whether as a result of drought or of burning and overgrazing the veld, accelerates erosive activity, by both sheet wash and gullying.

In many parts of the country the vegetative cover has been seriously disturbed by indiscriminate burning aimed at stimulating young growth for winter

and spring grazing.[3] While settlement was sparse and the veld was given long periods of rest, this practice, which the Europeans learnt from the Hottentots, was relatively harmless. But with the subdivision of farms, closer settlement, and the multiplication of stock numbers the rest period was progressively shortened. With repeated firing and overgrazing the vegetational succession was thrown back, the valuable redgrass disappeared from parts of the sweetveld to be replaced by harsher more resistant grasses, the vegetative cover of the Karoo was reduced, and in the south-west Cape the rhenoster bush gained possession of large areas. Yet so long as fodder crops were not grown there was little alternative but to fire the veld to get some winter grazing. The evils of this practice were accentuated by the practice of kraaling the animals at night. In the pioneering days farms were large, cheap fencing materials were not available and because of wild beasts – jackals and leopards especially – the domestic animals were collected inside a protective fence at night. Their dung accumulated in the kraals instead of being spread over the veld. Manuring was never practised, so the fertility of the land declined, and soil deterioration and soil erosion were hastened.

During the past twenty years, however, great changes have occurred and much progress has been made. In this the Forest and Veld Conservation Act of 1941 and the Soil Conservation Act of 1946 have played an important part. The former, by giving the Government power to proclaim as a Conservation Area, any area which, in the national interest, is deemed to require reclamation and conservation at public expense, ensured control in the worst afflicted areas. The 1946 Act carried the responsibility to the farmers themselves and placed the emphasis on the right use of the land and the adoption of methods of farming designed to conserve the vegetation and the soil, i.e. prevention rather than cure. To achieve this the act provided machinery for the establishment of a central Conservation Board composed of Government officials and bona fide farmers and for the formation, in those areas where the majority of the farmers desired them, of Conservation Districts to be administered by district committees having two-thirds of their members local farmers. In the Conservation Districts farming must be conducted in accordance with a soil conservation scheme prepared by the district committee and approved by the Minister on the recommendation of the Conservation Board. The conservation schemes aim at the reclamation of eroded land, the conservation of the soil, protection of water supplies, and promotion of good farming. They may limit the number of stock per morgen, enforce proper veld management, and insist on the proper rotation of crops. Most European farmers, realizing the dangers of uncontrolled soil erosion, have shown themselves prepared to accept these restrictions and their acceptance of the facilities accorded by the 1946 Act are reflected in Fig. 91.

It should be stressed that the progress made since 1946 has been possible by virtue of the research work on pastures, veld management[4, 5, 6] and soil conservation undertaken at the agricultural research stations and the universities. It has been aided by the home production of machinery and fertilizers and hastened by

economic circumstances favouring the development of more intensive and more mixed agriculture.

Studies in veld management have indicated that burning is beneficial only if carried out infrequently and in spring before the warm moist season of growth; and that all types of veld require a period of rest in order to ensure seeding and germination.[7] This rest period varies. A short one at any time of the year is adequate for the sweetveld. The sourveld and mixed veld require one year's rest

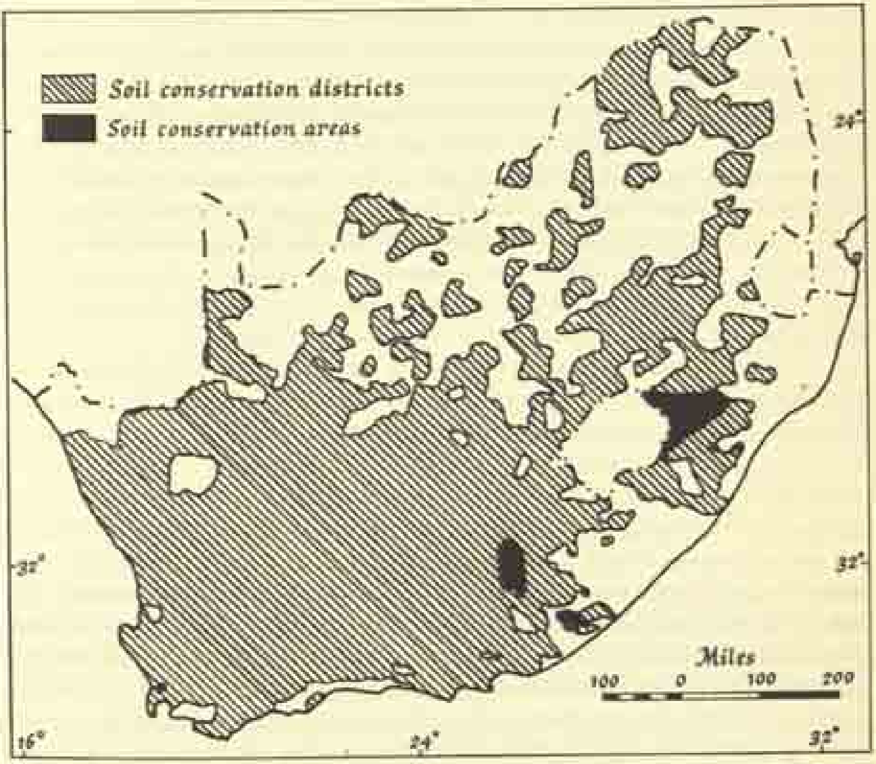


Fig. 91. Soil conservation districts and soil conservation areas in 1955. (From map in 8th annual report of the Soil Conservation Board 1st July 1954–30th June 1955, U.G. 32/1956.)

every four or five years and the Karoo veld a slightly longer one. Proper veld management necessitates rotational grazing, which has become possible since cheap wire fencing has become available, and is now increasing in all but the pioneering districts. This in turn is ensuring the spread of dung over the lands; pastures are also receiving artificial fertilizers. Pasture research has made available suitable grasses, hay and fodder crops for each region. In the south-western and south-eastern Cape pastures[8] of Italian ryegrass, perennial ryegrass, subterranean

clover, and wild white clover have been successfully established; in the Lowveld and Bushveld indigenous tufted grasses – Napier Fodder (*Pennisetum purpur*) babala, *Setaria* spp., and *Paspalum* spp., thrive, particularly if irrigated in winter while the leguminous twining vine *Glycine javanica* promises to control erosion and provide succulent feed in a manner similar to that of kudzu in the southern state of the U.S.A.; on the Highveld the mat grasses – Rhodes grass (*Chloris gayana*), kikuyu (*Pennisetum clandestinum*), and Nile grass (*Acroceras macrum*), succeed in the main cropping areas while the finger grasses (*Digitaria* spp.), quick grasses (*Cynodon* spp.), and such tufted grasses as blue buffalo grass (*Conchrus ciliaris*) and species of *Eragrostis*, *Panicum* and *Setaria* form good pastures in the drier areas. Formerly the poor seeding habits and underground propagation of the indigenous grasses, doubtless responses to drought and continued firing of the veld, retarded their use for pastures but since 1940 seed harvesting combines have been used to collect seed in the drier parts of the country and today machines are available for both seeding and planting. Parallel with the development of pastures, fodder crops have been introduced into the rotation in the arable areas. The possibilities of fodder trees – honey locust trees, spineless cactus, mesquite, spekboom, and saltbush in the dry region, Mexican hawthorn, carob, belhambra, and oak in the high rainfall areas are now being investigated.

All these developments are raising the fertility of the land, enabling it to produce bigger crops and increasing its stock carrying capacity. In some areas improved grazing, crop rotation, and mixed farming are facilitating a change in the main livestock enterprises. Thus cattle are increasing in areas formerly marginal for them while the close-clipping sheep and goat, responsible for so much selective grazing and overgrazing, veld deterioration, and erosion in the past, are losing ground except in the Karoo. Better feed is making possible better animals – good dairy cows and beef cattle – while better veld management and supplementary feed from irrigated areas is reducing drought hazards in the Karoo. More intensive farming in the better watered east promises the development of pig rearing and a general extension of poultry keeping, both of which have shown advances during the past decade. To conclude, the pastoral industries are now passing beyond the stage of pioneer development; they are becoming adjusted to the geographical environment; crop production is leaving the phase of exhaustive monoculture and, with the adoption of suitable crop rotations, is becoming increasingly linked with pastoral pursuits in the development of a mixed economy. South Africa, however, is still only on the threshold of scientific and mixed farming. Future progress will depend not only on the co-operation, good sense and goodwill of her farmers and the provision of trained agriculturists to act as field officers but also on the continued development of her manufacturing industries and on good markets at home and overseas for agricultural products. For prosperity is essential to agricultural progress.

BIBLIOGRAPHY

1. G. V. JACKS and R. O. WHYTE. *The Rape of the Earth.* London. 1939.
2. W. J. TALBOT. *Swartland and Sandveld.* O.U.P. Cape Town. 1947.
3. T. D. HALL. 'South African pastures, retrospective and prospective'. *S.A. J. Sc.*, Vol. XXXI, 1934.
4. J. D. SCOTT. *Conservation of Vegetation in South Africa.* Bur. Past. Aberystwyth, Bull. No. 41, 1951.
5. University of Pretoria. *Progress Report of the Grassland Research Committee, Faculty of Agriculture*, Ser. 1, Agric. No. 46, 1938.
6. J. W. ROWLAND. *Investigations into the Productivity and Management of the Natural Veld and Permanent Pasture . . . in the Pretoria District.* S.A. Dept Agric., Bull. No. 203, 1938.
7. J. P. BOTHA. 'Resting periods, a necessity for sound veld management'. *F. in S.A.*, Vol. XXV, 1949.
8. 'The pastures of South Africa'. *F. in S.A.*, Vol. XXVIII, 1952.

15

Forestry, Afforestation, and Forest Industries

South Africa is very poorly endowed with natural forest. The wooded areas total some 10 million acres but most of this is savanna and scrub 'open' forest. True 'closed' forests were never extensive (see ch. 3, p. 64) and today in consequence of over-exploitation, clearing for cultivation and the ravages of fire, those yielding saw timber cover only 500,000 acres, less than 0·2 per cent of the total area of the Union.[1] There are no true 'closed' forests in the Protectorates.

The Exploitation of the Indigenous Forests

Today, apart from small quantities of kiaat[2] (*Pterocarpus angolensis*), a valued furniture wood cut in the Lowveld, the savanna and scrub 'open' forests yield only fence posts and firewood. Today, as in the past, they are useful to the local inhabitants, but are of little economic significance.

The true 'closed' forests contain hundreds of tree species, mainly hardwoods, of which stinkwood (*Ocotea bullata*) and sneezewood (*Ptaeroxylon obliquum*) are the most valued, with some softwoods of which the yellow-woods (*Podocarpus* spp.) and the Cape box (*Buxus macowani*) occur in large numbers. The trees are distributed in an 'unsocial' fashion, a feature which led to the reckless destruction of the forests for the exploitation of the prized species.

The exploitation of the Knysna forests began in the late eighteenth century when the Dutch East India Company established timber posts at George and Plettenburg Bay[3] from which the timber was carried by sea to Cape Town. Subsequently the Plettenburg Bay post was run by the British Admiralty, and the forests denuded of hardwoods suitable for naval purposes. In 1869 a great fire devastated the forests over a 100 mile belt between Mossel Bay and Blaaukrantz and during the latter part of the century the mature timber of the remaining sections was removed to meet the demands arising from the development of the goldfields – for mine props, constructional purposes, wagons, and railway sleepers. After Union cutting was controlled and only the cutting of small

quantities of stinkwood and ironwood for furniture making and yellow-woods for railway sleepers has been allowed.

The forests of the south-eastern Cape, notably those of the Amatola mountains and the Alexandria coastal belt were first exploited about a century ago, the former for yellow-woods for constructional purposes, railway sleepers, and mine props, the latter for Cape boxwood, small quantities of which were exported. In Kaffraria, despite the introduction of forest regulations and the appointment of a Conservator in 1865, felling was often reckless, while the dry wood remaining encouraged the entry of grass fires which devastated large sections. At the same time the Bantu cut young saplings for hut building and deliberately destroyed the forests to make way for mealie gardens. The destruction of the forests followed a similar pattern in the Transkei whence many sawyers trekked following the introduction of forest regulations in Kaffraria. The coastal forests of the Transkei yielded appreciable quantities of sneezewood as well as boxwood.

Whereas in the Cape the forests, although ruthlessly exploited, remained Crown land, in Natal and the Transvaal they were alienated in the farms allotted to settlers. In consequence their destruction was more complete. In many cases farms were taken up simply for the timber they contained and then either abandoned or given out to the natives for mealie cultivation. Only in Zululand were the forests retained by the Crown. There those set aside for the Bantu were quickly ruined. Of the others the Qudeni forests were first exploited just before 1900 but such was the rate of extraction, particularly of yellow-woods, during the first world war, that today little timber remains. Only the inaccessible Nkandhla forest (Plate 21), containing less valuable trees, is left of the Zululand forests. In the Transvaal, however, virgin forest remains more or less intact at Mariepskop, while the western Soutpansberg contains appreciable quantities of large sneezewood and the Woodbush forests of hard pear.

Today there are few mature trees left in the remaining natural forests, only about 25 per cent of which, mainly in the Knysna and Tsitsikama areas, are considered exploitable. Since 1939, however, when the Forestry Department assumed control, operations have been largely restricted to the removal of dead and fallen trees in order to enable the young growth to mature. Recovery will, however, take many years for most of the species are very slow growing – under natural conditions in the Knysna forests common yellow-wood, stinkwood, and true yellow-wood take 156, 196, and 219 years respectively to reach a diameter of 19 inches at breast height. Under management growth might be accelerated but the return would not cover the expenses involved.

Timber Plantations

The Establishment and Extension of Timber Plantations

The inability of the natural forests to furnish the timber needs of the country coupled with the high cost of importing and hauling such a bulky commodity as

timber from the ports to the interior led to the establishment of plantations of fast growing exotic trees. The areas climatically most suitable for tree growth are shown in Fig. 92. Stimulated by the big demand for hardwoods on the goldmines the first plantations comprising eucalypts were established in the late nineteenth

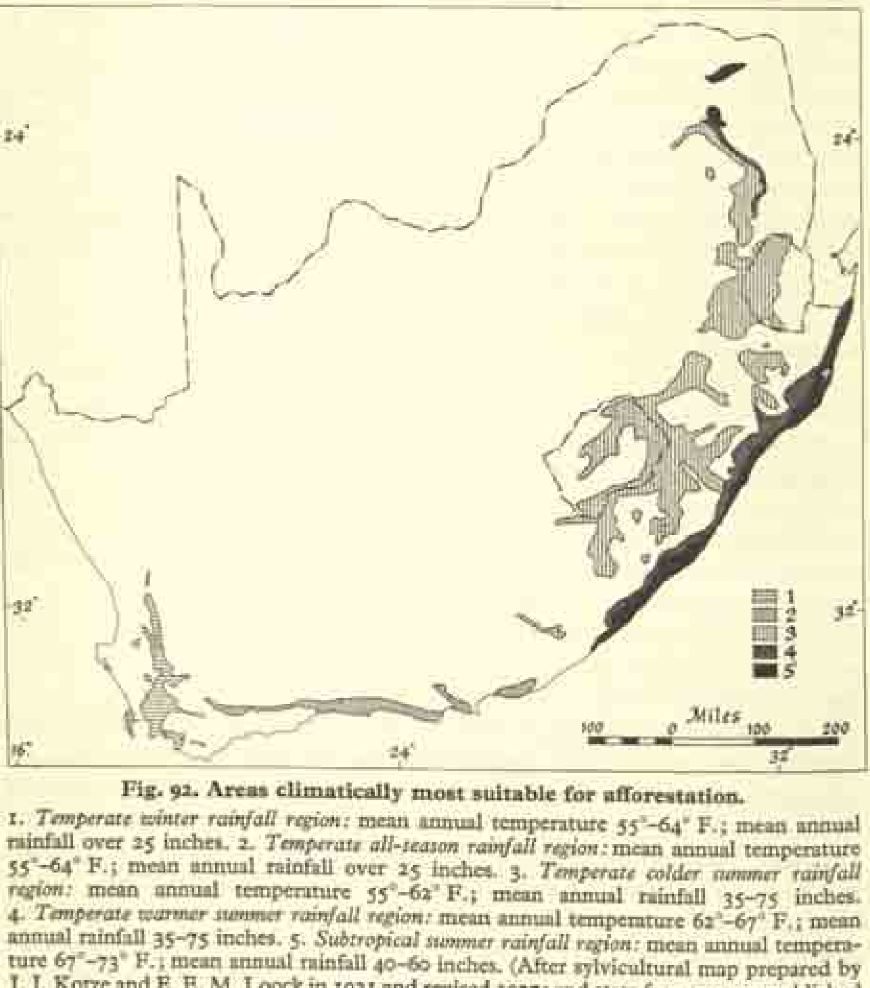


Fig. 92. Areas climatically most suitable for afforestation.

1. *Temperate winter rainfall region:* mean annual temperature 55°–64° F.; mean annual rainfall over 25 inches. 2. *Temperate all-season rainfall region:* mean annual temperature 55°–64° F.; mean annual rainfall over 25 inches. 3. *Temperate colder summer rainfall region:* mean annual temperature 55°–62° F.; mean annual rainfall 35–75 inches. 4. *Temperate warmer summer rainfall region:* mean annual temperature 62°–67° F.; mean annual rainfall 35–75 inches. 5. *Subtropical summer rainfall region:* mean annual temperature 67°–73° F.; mean annual rainfall 40–60 inches. (After sylvicultural map prepared by J. J. Kotze and E. E. M. Loock in 1931 and revised 1937; and state forestry map published in 1953.)

century by private landowners on the Transvaal Highveld, i.e. near to the consuming market. Soon afterwards small Government plantations of eucalypts and conifers were started in the south-western Cape and the eastern Transvaal for railway sleepers and harbour piles, and for mining and constructional timber respectively. Proving successful these plantations were gradually extended and

new ones started particularly during and after the first world war when the impossibility of importing large quantities of timber gave a tremendous fillip to afforestation. Private growers naturally concentrated on eucalypts grown on a short 8-to-12-year rotation for props, laggings, and mats for the gold mines. They were discouraged from planting conifers by the longer rotation necessary – the trees taking 20 to 40 years, depending on the species, to reach maturity and yield constructional timber – and by the low prices of imported softwoods. Afforestation with conifers was thus left to the State. In 1919 a State programme aimed at afforesting 10,000 acres annually in order to give an ultimate sustained yield of 50 million cubic feet per annum was adopted. With increasing timber consumption, however, the rate of planting was increased after 1931 and averaged 15,000 acres in the pre-war years.[4] By 1937 over 1·2 million acres had been afforested, of which, wattle plantations excluded, rather more than half consisted of eucalypts, mainly privately owned. By contrast 78 per cent of the trees in the softwood plantations were State owned (Table 7).

Table 7. Acreage under Forestry Plantations, 31st March, 1937 *

Ownership	*Conifers*	*Eucalypts*	*Wattles*	*Poplars*	*Other Species*	*Total*
State	226,197	50,220	38,187	1,438	8,577	324,599
Private and municipal	58,566	251,164	497,810	23,158	86,993	917,711
Total	284,763	301,384	535,997	24,596	95,570	1,242,310

* Until recently it has been the practice of the Department of Forestry to give the areas covered by their plantations in acres, not morgen.

In the years before the second world war the country consumed about 75 million cubic feet of timber annually, of which about 25 million cubic feet had to be imported. In 1937 the gold mines alone imported Baltic deal, Oregon and pitch pines for shaft timbers, sleepers, etc., to the value of £791,000, and bought mine props, laggings, and mats valued at nearly £1·5 million in the Union.[5] In 1939 the State planting programme for the next twenty-five years envisaged increasing the acreage under conifers to 590,000 acres giving a stabilized yield of 72 million cubic feet logs from 1980 onwards,[6] when, with private plantations contributing a further 18 million cubic feet, the total softwood production would reach about 90 million cubic feet.

During the second world war the great demand for packing cases of all kinds – e.g. for foodstuffs, ammunition, etc., for the forces – increased mining activity and industrialization caused increased demands for timber, which with imports severely curtailed, had to be supplied from Union sources. Fortunately, the inter-war plantations could provide the vital needs. At the same time the big annual profits – of from 75 to 262 per cent of the total capital outlay in some cases[7]

– so encouraged further private planting that between 1937 and 1950 the area afforested by private enterprise approximately equalled that carried out by the State and by 1950 the acreage under conifers exceeded that under eucalypts (Table 8).

Table 8. Acreage under Forestry Plantations, 31st March, 1950

Ownership	*Conifers*	*Eucalypts*	*Poplars*	*Wattles*	*Other Species*	*Total*
State	351,292	59,757	1,736	12,697	17,000	422,482
Private	162,784	287,004	28,126	611,666	17,440	1,107,020
Municipal	15,921	17,239	861	19,051	210	53,273
Native Areas	4,517	11,791	1,462	31,441	1,496	50,707
Total	534,505	375,791	32,185	674,855	36,146	1,653,482

After the war timber imports soon regained their pre-war level but three-quarters of the country's needs are now met by home-grown timber compared with two-thirds in pre-war years. The yield from the State plantations has increased to over 30 million cubic feet, of which over 20 million cubic feet is soft-wood saw-logs.[8] Private plantations supply around 10 million cubic feet of soft-wood saw-logs and about 30 million cubic feet of eucalyptus and wattle timber for the mines. Consumption, however, is increasing. In 1953 the mines alone bought poles, laggings, and mats valued at nearly £4 million in the Union and imported over £1·3 million worth of sleepers, fabricated and squared timber.[9] To meet future needs a greatly expanded State afforestation scheme, which aims at increasing the area under coniferous plantations to about 1·25 million acres in the next twenty-five years, to give an ultimate sustained yield of 200 million cubic feet, has been adopted.

Afforestation Areas

Generally speaking only those areas unsuitable for agriculture are used for afforestation. The area of first-class forest land thus available is limited, but its productivity is, however, very high compared with the cooler regions of the world. On moderately good sites fast and medium growing pines show an annual wood increment of 280 cubic feet per acre compared with increments in Germany of 50, Sweden 37, U.S.S.R. 35, U.S.A. 13, and Canada 7 cubic feet.[10] On first-class sites *Pinus Insignis* and *P. patula* show average annual increments of 410 and 425 cubic feet respectively in a thirty-year rotation.[11]

Naturally with differing climatic and soil conditions between and within the areas available for afforestation, a variety of exotic trees are grown, those most suitable for a particular locality being found through experimentation over a long period. Here the softwood and hardwood plantations must be considered separately.

The Coniferous Plantations

Successful coniferous plantations occur throughout all the areas of higher rainfall but the distribution of species depends on the seasonal incidence of the rainfall, the temperatures, and on the soils. Notably different species are grown in the summer rainfall area and in the south-western Cape.

By far the most important species is *Pinus patula* which, originating from the moist mountains on the eastern side of the Mexican plateau, covered nearly 110,000 acres in State plantations alone in 1954. It has been extensively planted on the moist east facing slopes between 3,000 and 5,000 feet in the eastern Transvaal (particularly in the Sabie-Pilgrims Rest area), Natal (near Harding), and the Transkei, where the temperatures resemble those of its native habitat, the rainfall exceeds 30 inches and mist is frequent (see Plate 56). Here it grows very rapidly, in 30 years attaining a height of 115 feet, a diameter of 18 to 19 inches and averaging a wood increment of 380 cubic feet. It yields a very light soft white wood eminently suited for boxes for agricultural produce.[12] It is, however, very sensitive to frost and drought. At higher altitudes therefore in the mist belt of the Transvaal and Natal and also at low altitudes in the Knysna area, *P. caribaea* which can withstand light frost is more generally planted where the soils are sufficiently deep. On poor soils and dry sites on the lower mountain slopes of the eastern Transvaal the relatively drought-resistant *P. longifolia* is grown. The latter, however, is a slower growing species giving an annual wood increment of only 150 cubic feet in 20 to 25 years; moreover its wood, while suitable for building purposes, is too hard and heavy for boxes. In 1954 *P. caribaea* covered over 77,000 acres and *P. longifolia* over 34,000 acres of the State plantations.

In the south-western and southern Cape *P. insignis* (*P. radiata* D. Don, native of the Monterey Peninsula of California)[13] with an annual wood increment of 360 cubic feet grows more rapidly than other conifers and yields timber which resembles Baltic deal and is excellent for building purposes and box shooks. It thrives, however, only in deep well-drained loam soils such as those derived from the Bokkeveld Shale or an admixture of Table Mountain Sandstone and Bokkeveld Shale, and hence is grown only on the lower mountain slopes where it occupies about 30,000 acres. On the acid sandy soils derived from the Table Mountain quartzites its growth is poor, while it suffers from fungus attack – by *Sphaeropsis pinicola* Speg – following alternate waterlogging and drought in the shallow ill-drained soils characteristic of the Malmesbury schist and the Cape granite. Here, however, the cluster pine, *P. pinaster*[14] succeeds; it covers altogether nearly 80,000 acres. Probably originally introduced by the Huguenots, it is found today in extensive plantations on the mountain slopes above those carrying *P. insignis*. But the tree grows more slowly than *P. insignis*, taking 40 years to reach a height of 80 to 90 feet and having an annual wood increment of only 110 cubic feet, and yields a less valuable timber. In suitable localities the Canary Island pine (*P. canariensis*) characterized by its straight unbranched trunk which is valued for transmission poles, thrives. Since, however, it requires

well-drained loam soils and is sensitive to wind, particularly the south-easters, it is grown only on the lower protected mountain slopes and its total acreage is small.

The Hardwood Plantations

The exotic hardwoods most extensively grown in South Africa are eucalypts, poplars, and wattles. The wattle plantations, however, have been established primarily for tan-bark production and yield timber only as a by-product. They

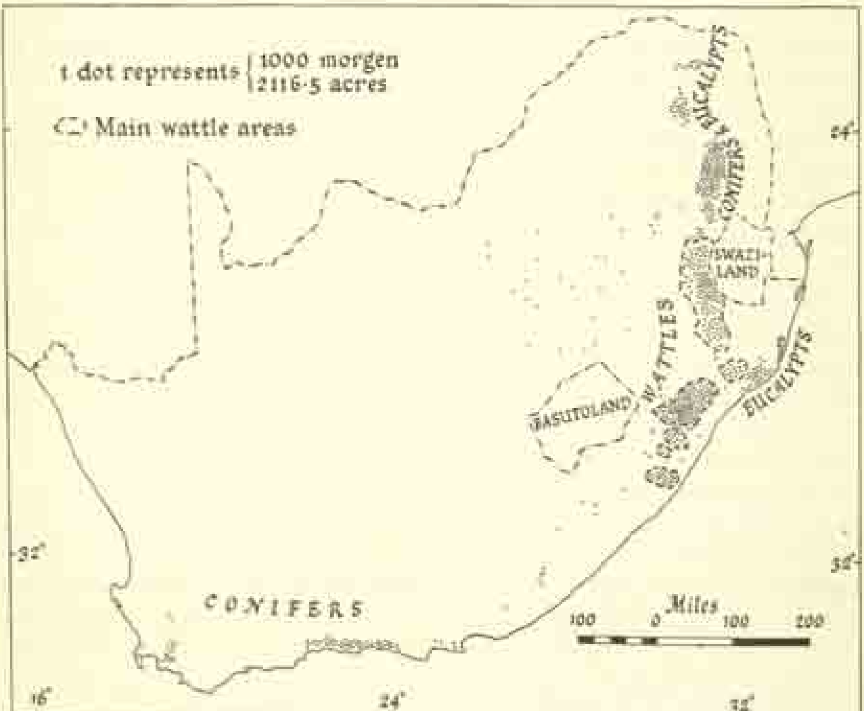


Fig. 93. The distribution of timber and wattle plantations.
(1949–50 census.)

are considered separately (pp. 261–3). Poplar trees covering altogether 30,000 acres and occupying the deep moist soils along streams in all parts of the country, are grown for matchwood. Hardwood plantations established primarily for timber production consist entirely of eucalypts.

Since few trees can equal certain species of eucalyptus for rapidity of early growth – from 50 to 60 feet with a girth of 7 feet in 12 years – and suitability of timber for mine props,[18] large plantations were established soon after the opening of the Witwatersrand goldfields. Some species can withstand prolonged drought

provided the soils are deep and allow root penetration to the ground-water level. For commercial timber production, however, an annual rainfall of at least 25 inches is necessary. Generally speaking the plantations extend into drier regions than those of conifers. The first plantations were established on the Highveld but the harsh climate and the ravages of the eucalyptus snout beetle (*Gonipterus Scutellatus* Gyll)[16] caused heavy losses and restricted the species that could be successfully grown. In consequence production has shifted to the southern slopes of the Soutpansberg, the Tzaneen and Sabie–Graskop areas of the Transvaal, the Midlands of Natal and the coast of Zululand. Recently there has been a tendency towards the establishment of plantations in drier areas, notably near Barberton and White River, below Logo Gota near the borders of the Kruger National Park in the Transvaal Lowveld and in Zululand. In all these areas the plantations have been established on deep loamy soils derived from the Old Granite, and retentive of moisture. In the higher cooler areas, e.g. Soutpansberg, Tzaneen, Sabie–Graskop, *Eucalyptus saligna* is the leading species. On deep soils derived from an admixture of granite and dolerite, it has an amazingly rapid rate of growth, putting on over 500 cubic feet annually. It is grown mainly for mine props. At lower altitudes in the Lowveld and in Zululand where the temperatures are higher, the 'spotted gum', *E. maculata*, which yields a good constructional timber, is preferred on deep soils. Under favourable conditions its annual wood increment exceeds 400 cubic feet.[17] In all areas the poorer sites, i.e. the hot northern and western slopes and the shallow sandy soils, are generally planted to *E. paniculata* which grows rapidly even under poor conditions. In the southern Cape and on the Highveld the Blue Gum, *E. diversicolor*, which successfully withstands the colder winters is the leading species.

The Wattle Industry

Plantations of black wattle – *Acacia mollissima* Willd – cover over half a million acres in the mist belt of Natal and the Transvaal, where the trees are grown for tan-bark. Maintained almost entirely by private enterprise, the plantations support the one forest industry[18] with a large and well organized export trade. Although the tree is indigenous to Australia and commercial planting began in Natal only after 1886, when the first trial shipment of chopped bark to England was made,[19] today almost all the wattle bark and extract entering international commerce derives from South Africa.

The plantations occur on slopes with an easterly or south-easterly exposure at altitudes between 2,000 and 4,500 feet in the Natal Midlands (Plate 73) and between 4,000 and 5,000 feet in the Piet Retief area of the Transvaal (see Fig. 93). Here the annual rainfall exceeds 35 inches, the minimum for healthy and vigorous growth, and frequent mist tempers the summer heat, reduces transpiration to a minimum, and favours the activity of two fungous diseases which destroy the wattle bagworm (*Acantopsyche junodi*), the chief pest of cultivated wattle.[20] At higher altitudes frost is a limiting factor, at lower altitudes the absence of mist,

lower rainfall, and higher temperatures are unfavourable. The trees thrive on a variety of soils provided they are deep and well-drained but the most vigorous growth occurs on soils derived from dolerite or Table Mountain Sandstone.

Wattle is grown in (*a*) large plantations of 2,000 to 5,000 acres, on estates owned either by the wattle extract companies or by individual growers and devoted entirely to wattle growing, (*b*) moderately large plantations (1,000 to 2,000 acres) on farms concerned also with dairying or crop production, and (*c*) small plantations (100 to 1,000 acres) on farms where general farming provides the main income.

The trees normally give the maximum yield of high-quality bark at about ten years, by which time they have attained the requisite diameter for mine props – the main use for the timber. Hence most plantations are managed on a ten-year cycle. New plantations are established either by sowing seeds, or by planting seedlings, after the land has been ploughed contourwise. Subsequent stands develop from natural regeneration. The application of fertilizers containing phosphorus, lime, and potash is usual in young plantations, being found to accelerate growth and enable the young trees to rise quickly above frost level. Frequent weeding is necessary until the canopy of foliage closes. Subsequently the plantations are gradually thinned to stands of between 250 and 700 trees per acre depending on site quality and the main aim of the grower, i.e. bark or timber. At ten years the trees are felled and the bark stripped (Plate 62). The bark is then either bundled and despatched as 'green bark' or dried in the open for four or five days and sent to the factories as 'stick bark'. Drying reduces the bulk and halves the weight of the bark and hence is usual on farms distant from a factory. After the bark and timber from the felled section have been removed the land must be cleaned to make way for the next generation of wattle trees. Formerly the waste timber and brushwood were burned but most farmers now realize that this practice impoverishes the soil and facilitates erosion. So today the waste is stacked in lines between the seventh and eighth rows selected for the next generation of trees and allowed to rot. All these operations make heavy demands on labour which, however, is forthcoming from the nearby African reserves, an important factor in the success of the industry.

Transport is more difficult. The cost of hauling bundled bark to the railways, even over long distances, by motor truck or ox-wagon, is small in relation to the value of the commodity; but the timber cannot be sold at a profit if the plantation is more than 9 miles from a railway. In those areas accessible to the railways focusing on Pietermaritzburg, to the Durban–Johannesburg main line and to the Piet Retief–Johannesburg line no difficulties are experienced. Elsewhere, notably in the Melmoth district of Zululand, the timber cannot be marketed and the full cost of wattle cultivation and exploitation must be borne by the bark. Altogether about one-third of the Natal wattle area does not market its timber.

At one time only wattle bark was exported. Now two-thirds by weight and five-sixths by value is extract (Fig. 94). The production of tannin extract began

in 1916 when wartime shipping difficulties caused a loss of export markets for bark, and for similar reasons expanded greatly during the second world war. Today there are four large factories located at Pietermaritzburg, Melmoth, Paddock, and Piet Retief, the first mentioned being responsible for one-third of the total output. These factories are owned by the Natal Tanning Extract Company which controls 60 per cent of the export trade. Before the war the extract

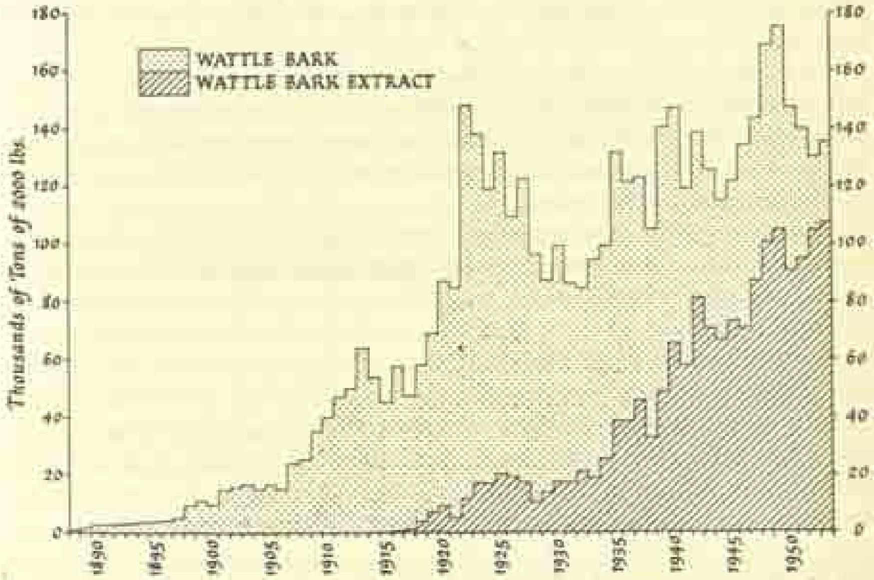


Fig. 94. Exports of wattle bark and extract 1889-1956.

was exported mainly to Great Britain, the bark to India and Japan.[21] Since 1945, however, due partly to increased difficulties in the production of quebracho in the Argentine and to chestnut blight at home, the U.S.A. has become the most important buyer of bark and is second to the U.K. as a buyer of extract with Australia following closely. Since the decline of the quebracho industry is inevitable – afforestation could not meet the present rate of exploitation – increasing world markets for wattle extract seem assured, so that the outlook for the South African industry is bright.

Other Forest Industries

Sawmilling

The modern sawmilling industry is very much a product of the second world war. In 1939 there were only some small privately owned plants and two state sawmills, the latter dealing with less than 0·6 million cubic feet of softwood sawlogs annually. During the war the industry expanded rapidly to meet the

unprecedented demand for home grown timber and by 1945 there were 137 private sawmills and 12 state sawmills, together dealing with 17 million cubic feet of softwood sawlogs supplied by the Government plantations and the former also with privately grown timber. Most of the private sawmills were small concerns with an input of less than 350,000 cubic feet of sawlogs. Two of them and three of the state mills, however, had capacities exceeding 1 million cubic feet of sawlogs. Since 1945 the sawmilling industry has continued to expand. In 1954 the supply of softwood sawlogs from State plantations exceeded 20 million cubic feet of which 8 million cubic feet were processed in state sawmills and nearly 13 million cubic feet sold to private concerns, the Government policy being to produce logs for private mills but to maintain state sawmilling to prevent the growth of monopolies. The private mills dealt also with about 9 million cubic feet of softwood sawlogs from private plantations and some 30 million cubic feet of eucalyptus and wattle for mining timber.

Since the volume of sawn timber is less than half that of sawlogs the sawmills are located within the afforested districts. Sawn timber too is a bulky commodity so that sites with railway facilities are desirable. Hence the main concentrations in the Sabie–Pilgrims Rest area, near Tzaneen, Pietermaritzburg, and George and in the south-western Cape. State timber preservation plants are found at Bellville (Cape Town), George, Stutterheim, Port Durnford, and Pretoria while factories preparing eucalyptus and wattle timber for the mines are located on the East Rand and at Pietermaritzburg. Dependent on the sawmills are the factories making boxes and shooks. These cater principally for the fruit growers and hence are found mainly in the Transvaal Lowveld and in the south-western Cape.

The Wood Pulp and Paper Industries

The large-scale production of wood pulp and paper in South Africa is a new development encouraged by recent technical advances permitting the use of eucalyptus and wattle as well as pine timber. It has been stimulated by the shortage and high cost of imported pulp and paper during the war and post-war years, encouraged by the success of the pulp and paper factory using wheat straw and pine wood which came into operation at Springs in 1939 (Plate 134) and aided by loans from the Industrial Development Corporation. As yet, however, it is still in its infancy. A large pulp and paper mill located at Mandeni near the mouth of the Tugela river came into operation in 1954. Well placed with regard to supplies of timber and water it will consume over 6 million cubic feet (90,000 tons) of pulpwood annually. A new rayon mill at Umkomaas takes 100,000 tons of wood annually and fibre board factories at Canelands in the Natal sugar belt and at Estcourt in the Natal Midlands absorb large quantities of eucalyptus and wattle wood respectively. These developments have prompted new afforestation schemes both by the State and by private enterprise in Natal and Zululand.

Afforestation and Water Supplies

The influence of forestry plantations on water supplies[22,23] has been the subject of much controversy, the drying up of vleis and the reduction of stream flow in some parts of the country – notably the Transvaal Lowveld and the south-western Cape – being attributed by some people to the establishment of nearby plantations, by others to the decreasing rainfall since 1925. Probably decreasing rainfall is the main cause. Trees take up and transpire large quantities of ground water but in areas of good rainfall the amount withdrawn is replenished, a process aided by the forest cover which retards floods and ensures downward percolation. In dry areas, however, freely transpiring tree species may remove more water from the soil than can be returned by the rainfall. In all regions swampy areas naturally tend to dry up as the natural succession progresses towards a forest climax, and likewise if trees are planted near them. This suggests that afforestation should be restricted to areas of high rainfall and where the discharge of the streams is required for irrigation, domestic, or industrial purposes, the areas along their banks should not be planted up.

Contentions have also been made that plantations of conifers and eucalypts actually impoverish the land, the trees depleting the soils of plant nutrients, killing off the natural ground vegetation and contributing little humus forming material themselves. In the warm moist country near Duivelskloof in the eastern Transvaal, however, plantations of eucalyptus saligna have actually been shown to improve the land[24] – by arresting erosion and building up its fertility – to such an extent that excellent pastures giving big hay crops, have been obtained following their felling.

It would thus seem that, provided sites are wisely selected, plantations of exotic trees make a valuable contribution, both as sources of timber and as protectors of the land, to the economic life of the country.

BIBLIOGRAPHY

1. N. L. KING. 'Tree planting in South Africa'. *J.S. Afr. For. Ass.*, No. 21, 1951.
2. M. H. SCOTT. 'The properties and uses of South African kiaat (*Pterocarpus angolensis*), timber'. *J.S. Afr. For. Ass.*, No. 7, 1941.
3. N. L. KING. 'The exploitation of the indigenous forests of South Africa'. *J.S. Afr. For. Ass.*, No. 6, 1941.
4. Annual Reports of the Union of South Africa, Department of Forestry, Pretoria.
5. Annual Report of the Transvaal Chamber of Mines, Johannesburg, 1937.
6. I. J. CRAIB. *Thinning, Pruning and Management Studies on the Main Exotic Conifers grown in South Africa.* S.A. Dept Agric. and For., Sc. Bull. No. 196, 1939.

7. Union of South Africa, Board of Trade and Industries, Report No. 304, *The Sawmilling Industries*, Pretoria, 1947.
8. Annual Report of the Department of Forestry for the year ended 31st Mar. 1954. U.G. 38/1955.
9. Annual Report of the Transvaal and Orange Free State Chamber of Mines. Johannesburg. 1953.
10. I. J. CRAIB. 'State afforestation after the war'. *J.S. Afr. For. Ass.*, No. 9, 1942.
11. I. J. CRAIB. *Thinning, Pruning and Management Studies on the Main Exotic Conifers grown in South Africa.* S.A. Dept Agric. and For., Sc. Bull. No. 196, 1939.
12. N. L. KING. 'Tree planting for commercial purposes'. *J.S. Afr. For. Ass.*, No. 8, 1942.
13. F. S. LAUGHTON. 'The effects of soil and climate on growth and vigour of *Pinus radiata* D. Don, in South Africa'. *S.A. J. Sc.*, Vol. XXXIII, 1937.
14. G. A. ZAHN. 'The Cluster Pine (*P. pinaster*), at the Cape'. *S.A. J. Sc.*, Vol. XXVI, 1929.
15. Union of South Africa, Board of Trade and Industries, Report No. 245. *The Timber and Sawmilling Industries.* Pretoria. 1939.
16. F. G. C. TOOKE. 'The history of Eucalyptus Snout Beetle control'. *F. in S.A.*, Vol. XXVIII, 1953.
17. J. J. KOTZE and C. S. HUBBARD. 'The growth of Eucalyptus in the sub-tropical plantations of the northern Transvaal and Zululand'. *Emp. For. J.*, Vol. IX, 1930.
18. See M. DYLYS BIRKBY. 'The wattle industry in Natal'. *Geog.*, Vol. XXXVI, Pt. 3, No. 173, 1951.
19. S. P. SHERRY. *The Silviculture of the Black Wattle.* S.A. Dept For., Bull. No. 31, 1947.
20. A. J. O'CONNOR and I. J. CRAIB. 'Silvicultural investigations of the black wattle (*Acacia mollissima* Willd)'. *S.A. J. Sc.*, Vol. XXVI, 1929.
21. I. J. CRAIB. 'South African wattle bark and wattle extract with particular reference to the American market'. *J.S. Afr. For. Ass.*, No. 6, 1941.
22. T. W. GEVERS. 'The drying rivers of the north-eastern Transvaal'. *S.A.G.J.*, Vol. XXXI, 1949.
23. C. L. WICHT. *Forestry and Water Supplies in South Africa.* S.A. Dept For., Bull. No. 33, 1949.
24. H. A. READ. '*Eucalyptus saligna* and soil reclamation'. *J.S. Afr. For. Ass.*, No. 7, 1941.

16

Fishing and Whaling

The Growth of the Fishing Industry

Although 95 per cent of the total world catch of marine fish is taken in the northern hemisphere, South Africa is, by virtue of rapid developments since 1944, an important fishing country. With the largest industry in the southern hemisphere, its landings today work among the first ten in the world.[1]

Until the beginning of the century when the trawl fisheries were established, small inshore boats supplied the limited local market. After a difficult start the trawl fisheries developed steadily and provided the bulk of the fish landed until 1946–7, when they were outstripped by the inshore fisheries, which developed very rapidly along the west coast of the Union and South West Africa after 1944.

As with so many industries in South Africa the development of the marine fisheries has depended on Government aid. Thus the discovery of the Agulhas bank[2] and the growth of trawling date from the fisheries survey commenced by the Cape Government in the late nineteenth century. The expansion of the whole industry and especially of inshore fishing after 1944 followed the establishment of the Fisheries Development Corporation charged with making loans from Government funds for the construction of new boats and gear, the provision of electricity and water schemes – vitally necessary along the arid, sparsely peopled west coast – the modernizing of factories and the provision of housing and social amenities for fishermen.[3]

Before 1939 the annual catch, exclusive of crawfish, was normally about 50 million lb. valued at £550,000; crawfish valued at £476,000 were taken so that the total value of the catch was about £1 million. There were just under 1,500 registered boats, mostly rowing and sailing vessels, and the total investment in the industry was only about £1 million. By 1948 the catch, at 270 million lb., had quintupled and its value risen to over £6½ million. Forty trawlers, 713 motor vessels, and around 1,500 small craft were engaged in the industry which provided employment for about 5,000 fishermen and some 6,000 workers in the processing plants. By 1952 the catch had leapt to over 1,200 million lb. or about 633,000 tons, yielding about 243,000 tons of fresh and processed products valued at about

£13 million. There were 2,750 registered fishing boats representing a capital investment of around £13 million, some 7,000 fishermen and twenty-five modern factories on the west coast employing some 7,500 people.

The per capita consumption of fish in South Africa is extremely low, in 1944 being estimated at only 4½ lb.[4] compared with 41 lb. in Great Britain, 55 lb. in Holland, and 70 lb. in Norway. Because of various taboos the greater part of the Bantu population is non-fish eating, while difficulties of communications in the interior hamper the development of a fresh fish trade. The growth of the fishing industry has thus been concomitant with the expansion of the processing industries and the development of an export trade.

Although the division is not clear cut, generally speaking the coastal and inshore fisheries supply the processing factories and the trawl or deep-sea fisheries cater for the fresh fish trade.

Oceanographic and Biological Conditions

The commercial fishing activities depend in the first instance on the abundance of palatable fish in the coastal waters and on the extent of the areas suitable for exploitation. Both are influenced by the depth, form, and nature of the sea bed; the species and numbers of fish depend also on the temperature and salinity of the waters and the amount of plankton they carry.

Altogether the waters around Southern Africa contain 1,275 known species of fish. Of these 315 are endemic, 675 belong to the Indo-Pacific region, 62 including the Cape hake or stockfish (*Merluccius capensis*), kabeljou (*Sciaena hololepidota*), French sole, and John Dory to the Atlantic region and 35 including snoek (*Thyrsites atun*) and kingklip (*Genypterus capensis*) to the sub-Antarctic region. There are 100 deep-sea and 88 cosmopolitan species.

The distribution of these species is governed largely by oceanographic conditions, ocean currents being particularly important. Thus the tropical waters off the east coast, washed by the warm Agulhas current, contain many species, but comparatively small numbers of fish. By contrast the cooler Atlantic waters are suitable for fewer species but rich feeding grounds, where plankton find the phosphate and nitrate rich upwelling cold waters of the Benguela current very favourable, support large quantities of fish.[5] Moreover among these fish are the most valuable commercial varieties. The southern coastal waters are of intermediate but variable character.

Because of the differing temperature and salinity conditions, individual species are generally restricted in their distribution to the waters of either the east coast or the west coast but due to the fact that the sea is less influenced by currents at depth than it is near the surface, some relatively deep water species, such as stockfish and kingklip which mainly inhabit the waters off the west coast, occur in comparatively large numbers as far east as Algoa Bay.

The continental shelf extending to a depth of 100 fathoms normally affords the most favoured fishing grounds. Around South Africa it is relatively narrow

(Fig. 95). Along the Natal coast it averages only 15 nautical miles; it widens gradually to about 25 miles off Cape St Francis and then, as the Agulhas Bank, broadens rapidly to a maximum of 120 miles west of Knysna. From Cape Agulhas to Cape Point the shelf narrows from 43 to less than 7 miles and along the west coast, except for a local widening off the Orange river mouth, it is only from 12 to 40 miles wide. Under favourable conditions trawling may be carried on to a depth

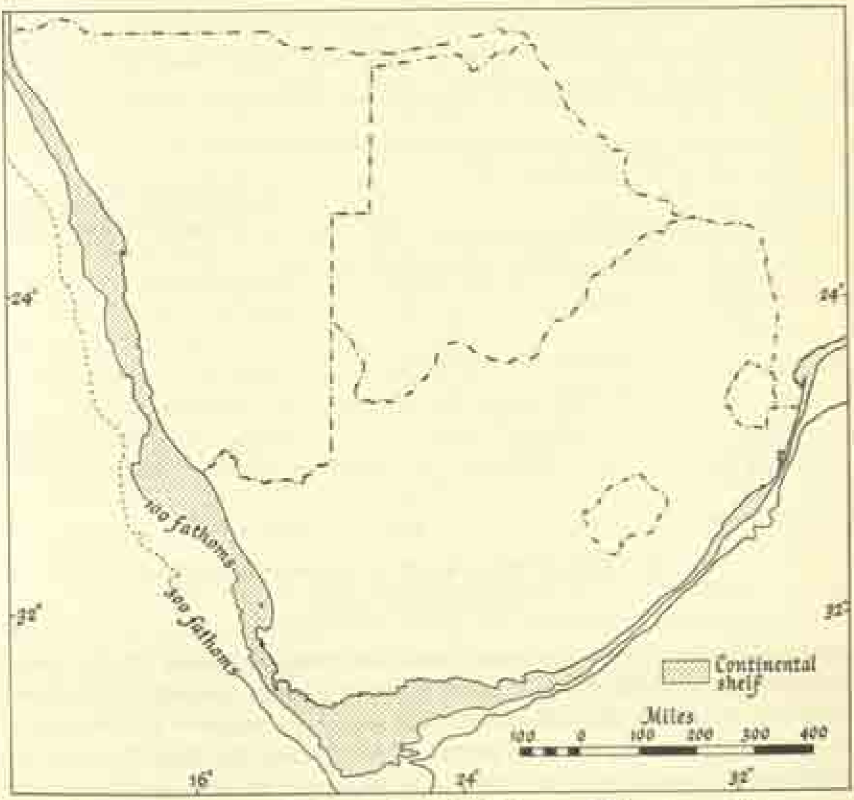


Fig. 95. The extent of the continental shelf around Southern Africa.

of 300 fathoms on the continental slope. Where this is practicable as between Cape Point and Saldanha Bay and between Cape St Francis and Port Alfred the 300 fathoms isobath is respectively 30 to 65 miles and 25 to 32 miles offshore. Compared with the northern hemisphere the areas of a depth and slope suitable for trawling are of limited extent while the nature of the sea-bed, often rocky, sandy, or coral strewn, restricts operations to a number of grounds, usually of small extent, where conditions are favourable.

The Deep Sea Fisheries

Trawling[6] is the most important operation of the deep-sea fisheries and provides the bulk of the supplies for the fresh fish trade. The main trawling grounds are shown on Figs. 96 and 97. Most important is the West Ground extending from Saldanha Bay to Cape Point and bounded by a rocky sea-bed to the north, east, and south. First discovered in 1920 it has been fished with increasing intensity ever since, yielding mainly stockfish and kingklip. Only a comparatively small exceptionally favourable area with an average depth of 185 fathoms some 45 nautical miles from Cape Town is as yet intensively fished. Here so far there has been no indication of a decline in the number of fish or in the percentage of large

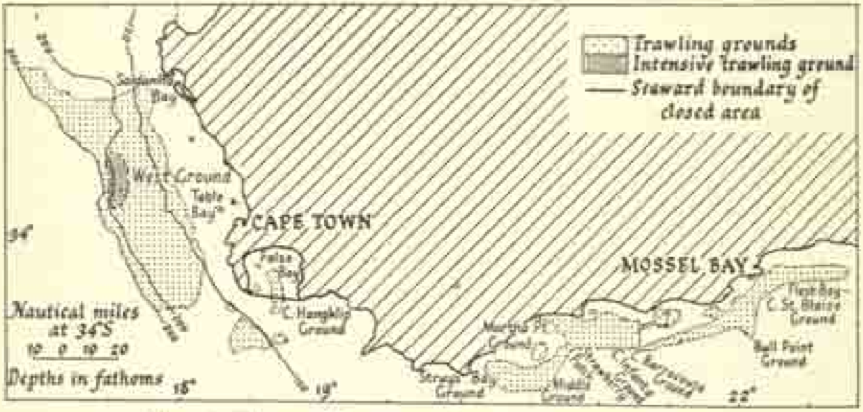


Fig. 96. The trawling grounds of the south-west Cape.
(Adapted from P. Scott.)

fish caught over a period of years[7] while the remaining areas of the ground promise great reserves for the future. Potential trawling grounds occur farther north but at present are fished only occasionally for stockfish and kingklip in winter, when there is a seasonal decline in yields from the West Ground. The small grounds around the Cape Peninsula, important in the early days, are too small for modern trawling while False Bay has been closed to trawling since 1928 in order to protect the inshore fisheries. Farther south and due west of Danger Point larger grounds are regarded as reserves for the future.

On the Agulhas Bank areas of clear mud bottom are interrupted by outcrops of rock and coral and the trawling grounds are less extensive than is generally supposed. The largest are the Struys Bay, Cape Infanta and Cape Barracouta grounds in the west and the Bull Point and Cape St Blaize grounds in the east. The former groups are visited by large trawlers from Cape Town, the latter by small trawlers based on Mossel Bay. All lie within the 50-fathom line; their shallower northern waters where the mud bottom is free from rocks constitute valuable sole fisheries; but owing to the sandy bottom this fish is absent from the

deeper southern waters. A great variety of other species are also present but those occurring in large quantities such as panga, white stumpnose and gurnard fetch only low market prices while good catches of the more valuable stockfish and kabeljou are rare.

Trawling grounds within the 50-fathom line occur also off the south-east coast, the most important being the Roman Rock ground – situated within Algoa Bay and long exploited on account of its sheltered position from northerly and westerly winds and proximity to the safe harbourage and large urban market of Port Elizabeth – Jeffreys Bank, Cape Padrone, and Chalumna River grounds. In winter stockfish leave these grounds for deeper waters. Their consequent

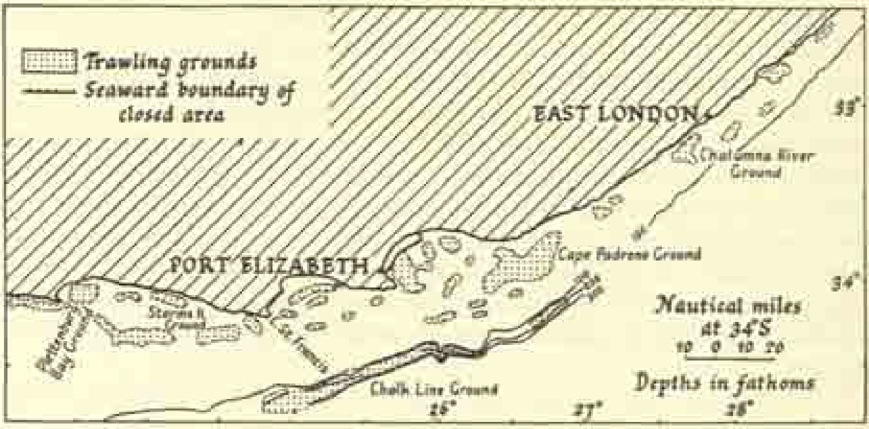


Fig. 97. The trawling grounds of the south-east Cape.
(Adapted from P. Scott.)

scarcity hampered the development of the trawling industry in Port Elizabeth and East London and prompted the survey of the deep water areas for alternative grounds in 1935–7. The Chalk Line Ground at a depth of 100 to 300 fathoms on the upper part of the continental slope forming the limit of the Agulhas Bank was discovered and has since been exploited. The strong Agulhas current, however, necessitates trawling in a westerly direction and in winter when westerly gales, being in opposition to the current, produce heavy seas, trawling is hazardous if not impossible.

Apart from a crawfish ground near Durban which is not exploited at present, no trawling grounds have yet been found on the Natal coast where the sea-bed has a coral-strewn or rocky nature.

The trawler fleet comprises 40 vessels manned by around 800 men and owned by five companies. Thirty trawlers are based on Cape Town, four on Port Elizabeth and three each on East London and Mossel Bay, this distribution being related to the distribution and productivity of the main fishing grounds, the

availability of dockyard facilities for repairs and bunkering, and offloading and transportation facilities to important markets.

At Cape Town most vessels are steam trawlers of 250 to 515 tons gross, with a fish capacity of up to 160 tons. These operate mainly on the West Ground and remain at sea for 7 to 10 days. Smaller motor vessels exploit the Agulhas Bank. Cape Town trawlers normally land about 86 per cent of the total catch. The trawlers based on Port Elizabeth and East London restrict their operations to nearby grounds, but since they engage in deep-water trawling in strong currents on the Chalk Line ground, they are fairly large steel vessels with a fish capacity of 40 to 75 tons. Before 1942 East London landed more fish than Port Elizabeth but with the development of the Chalk Line ground the latter port has risen to second place. The Mossel Bay trawlers are small, being of less than 100 tons gross with a fish capacity of 10 tons, and engage only in local fishing.

In 1952 the total catch of the trawling industry amounted to nearly 63,000 tons or about 125 million lb., four times the pre-war landings and 50 per cent more than the 1948 catch. The stockfish or Cape Hake, a cold-water species closely related to the European hake, and for long the mainstay of the trawling industry, is the most important species, comprising 75–80 per cent by weight and 65–70 per cent by value of the total catch. Sole, the most highly prized of all South African fish, is second in value but fourth in landed weight. Panga (*Pterogymnus laniarius*) and gurnard (*Chelidonichthys capensis*) taken on the Agulhas Bank, kingklip and kabeljou and a number of species of minor importance complete the catch.

Nearly 80 per cent of the fish landed are sold in a fresh or frozen state. Of the Cape Town landings 30 per cent is sold locally, 25 per cent is railed to Johannesburg for distribution throughout the Transvaal, Rhodesias and Portuguese East Africa, about 20 per cent distributed through the western Cape Province or sent to the High Commission Territories or Durban and 20 per cent to Cape Town smokeries. During recent years lightly smoked stockfish fillets have ousted imported smoked haddock on the home market and provided a surplus for export to Australia, Singapore, and Hong Kong. Factories in Cape Town and Port Elizabeth use stockfish livers in the manufacture of vitamin-bearing oils. The fish landed at Port Elizabeth and East London is sold mainly in the nearby towns but in good seasons small quantities are railed from East London to Bloemfontein and Johannesburg.

The Inshore Fisheries

Commerical inshore fishing is concerned mainly with pilchards (*Sardinops ocellata*) and maasbankers (*Trachurus trachurus*) and to a lesser extent with crawfish (*Jasus lalandii*), snoek and other species.

The presence of enormous schools of pilchards along the west coast of the Union and South West Africa has been known since 1929 but no attempt at their exploitation was made until 1943–4 when two companies began small-scale

operations. In 1945–6 the Fisheries Development Corporation assisted other companies in the establishment of a factory for the production of fish meal and body oil in St Helena Bay. In that season 7,500 tons of pilchards and maasbankers were landed and processed. It was not until five years later, however, that the potential wealth of the pilchard fishery was recognized and exploitation really began. In 1949–50 125,000 tons were landed and three years later the catch, obtained by netting, reached 543,000 tons.

The location of the industry is naturally dependent on the movements of the fish and the presence of harbour facilities. Fishing follows the migrating shoals which appear off Walvis Bay from October to January, reach Port Nolloth from February to May, Saldanha Bay and Table Bay from April to June and Mossel Bay from May to July. The industry is concentrated at Saldanha Bay, St Helena Bay, Lamberts Bay, and Walvis Bay where there are processing factories (see Plate 57). At the last named alone 250,000 tons of fish valued at over £1 million are landed annually for processing in six factories.

There were several reasons for this rapid development of the pilchard industry along the inhospitable semi-desert west coast where the provision of fresh water for boats, domestic supplies, and processing factories necessitated special Government schemes (ch. 7, p 152.) and where the fishing villages are remote from a railhead. First and foremost was the demand for its products. The disorganization caused by the war created an enormous world demand for protein foodstuffs. In South Africa itself the demand for canned fish could no longer be met from overseas. Existing canneries flourished. After the war they were re-equipped and new ones started. There was some export of canned pilchards. Most important, however, was the establishment of reduction plants for the manufacture of fish meal and fish body oil, a venture pioneered by the Fisheries Development Corporation. This was greatly assisted by the decline of the Californian pilchard fisheries – from a record catch of 791,000 tons in 1936–7 to 128,000 tons in 1951–2 and only 2,000 tons in 1952–3 – which meant that quantities of new and near-new equipment became redundant and were readily obtained by South Africa. Moreover the South African pilchard and maasbanker industry enjoys certain advantages over its competitors, particularly the occurrence of both fish in the same waters. Since the seasons for these species differ, continuous fishing by a single fleet over ten months of the year is possible. By contrast in the U.S.A., where the equivalent species, the pilchard and menhaden, respectively occur off the Californian coast and the Atlantic seaboard, two separate fleets are necessary, each operating for only three to four months of the year.

Before the war the crawfish or rock lobster industry was the most lucrative of the inshore fisheries, but is now eclipsed by the pilchard and maasbanker fisheries. Fishing for crawfish is carried on in the cold waters between the low water mark and 20–25 fathoms along the west coast from Cape Point to Luderitz; the fish is processed in local canneries. Before 1939 most of the output was exported to France in canned form. Since 1946, however, the U.S.A. has taken large

quantities of both frozen tails and canned fish. Shortly after the war the export of frozen tails reached such proportions that in order to conserve the fisheries a ceiling of 7·4 million lb. was placed on exports and a quota allocated individual concerns. In 1952 the output of processed crawfish was valued at £2½ million.

The mainstay of the line fishermen has long been the snoek which is caught almost everywhere from Walvis Bay to East London. It occurs in migratory shoals which appear off Walvis Bay from October to January and more southwards and eastwards in the waters between False Bay and Mossel Bay in the period May–July. The annual catch is around 10,000 tons valued at £½ million. The fish caught north of Saldanha Bay are generally salted and sent to Cape Town but most of those taken around the Cape Peninsula and along the south coast are sold fresh, only a small proportion being canned. Other fish taken include stockfish, kabeljou, and silver fish (*Polysteganus argyrozona*). Line fishing is carried on from numerous small harbours – Kalk Bay, Hermanus, and Gansbaai, where the Government has provided special facilities, being most important – as well as from Mossel Bay and Port Elizabeth. A number of line fishing boats operate out of Durban but because of the storms off the coast, fishing in Natal waters is not profitable over more than a few months each year. Line fishing landings average about 30,000 tons annually, a large percentage of which is handled by the trawler companies anxious to add variety to their trawler catch.

The takings of soupfin sharks for the extraction of oil from their livers was formerly important, but since the collapse of the vitamin oil market in 1949–50, following the successful production of synthetic vitamins, shark fishing has declined.

The great expansion in the inshore fisheries has been accompanied by changes in their organization. Before 1944 most of the factories were owned by small private companies often virtually family businesses. With the need for large capital outlays for the new canneries and reduction plants and the promise of large profits, ownership has passed into the hands of large public companies. At the same time the fishing and processing branches of the industry have become separated. Formerly fishing was carried out in factory owned vessels in charge of skippers who shared the profits with the company. Now a new class – the owner skipper – has emerged, being assisted in the purchase of craft by loans from the factories and the Fisheries Development Corporation. At the same time boats have tended to increase in size and today some are capable of landing up to 85 tons of fish. The earnings of the fishermen have increased in a spectacular fashion so that today prosperity and decent living conditions have replaced the abject poverty of the pre-war years.

Largely as a result of the second world war the canning industry has expanded greatly. Before 1939 the canneries concentrated on rock lobsters, but during the war other species were given increasing attention. In 1952–3 a total of

94 million lb. was canned, of which 63 million lb. were pilchards, 23 million lb. maasbankers, and 7 million lb. crawfish. At the same time the fish meal and fish oil industries developed, the output of meal reaching 78,382 tons in 1952 and that of fish oil 18,781 tons. The output of the fishing industry as a whole in 1952 is summarized in Table 9.

Table 9. The South African Fishing Industry. The 1952 Catch and its Utilization

Product	*Composition*		*Market Value**
		Tons	
Canned Fish (other than Rock Lobster)	Pilchards	17,036	£3,000,000
	Maasbankers	11,563	
	Stockfish	426	
	Snoek	156	
Fish Meal	Pilchard and Maasbanker	78,382	£2,900,000
	White fish meal	4,700	
	Rock Lobster meal	4,102	
Fresh and Frozen Fish (including Fillets)	Trawling	62,964	£2,700,000
	Line-fishing (A small proportion of this catch is consumed by processers)	30,000	
Rock Lobster (canned and frozen)	Round weight	15,000	£2,500,000
Fish Body Oil	(Recovered in reduction of Pilchards and Maasbankers to meal)	18,781	£1,200,000
Other Products	Vitamin Oil, Dried Shark, etc.		£600,000
			£12,900,000

* Based on prices realized by producers and manufacturers, due allowance having been made for the fact that local prices are in most instances lower than those obtaining abroad.

Fish meal and body oil find a ready sale both on the South African market and abroad. Under agreement with the Union Government the requirements of local consumers are satisfied before export is effected. Union consumers are supplied at prices well below world market prices, all sales being effected through the South African Fish Meal Producers Association and the South African Fish Oil Producers Association which pool the proceeds on the basis of annual production among members.

Government Control and the Future

While the modern fishing industry is healthy and thriving, the Government has taken measures to ensure its continued prosperity. Thus, warned by the failure of the Californian sardine industry, in order to safeguard the pilchard industry from over-exploitation, limitations have been imposed on the number and

capacities of the reduction plants and canning factories, and on the numbers of boats operating while a four months closed season has been imposed. Crawfish sanctuaries have been established and certain areas, notably breeding grounds, closed to trawling. Regulations regarding the size of mesh of nets have been enforced to avoid the large-scale destruction of immature fish.

At the same time wages and working conditions for fishermen have been made subject to control. To encourage consumption maximum prices for fresh fish on the South African market are fixed by a Price Controller. Prices have naturally risen since 1939 but the South African consumer enjoys cheaper fish, either fresh or canned, than consumers in Europe. Per capita consumption has risen to 7 lb. and could be considerably increased if the taboos which exist among certain Bantu tribes could be overcome, and the Native diet thereby greatly enriched by the introduction of this cheap protein food.

The Whaling Industry

Whaling operations both off the South African coast and in the Antarctic are conducted from South African ports. The industry, as in other parts of the world, has had a somewhat chequered career.

Six species of whale – the humpback (*Megaptera nodosa*), fin (*Balaenoptera physalus*) blue (*B. musculus*), Sei (*B. borealis*), sperm (*Physeter macrocephalus*), and the southern smooth whale (*Balaena australis*) are found in South African waters when they migrate northwards in autumn.[8]

In the early part of the century whaling operations in South African waters were second only in importance to those of the Antarctic, reaching a peak in 1913, when over 9,000 whales were taken and 40,000 tons of oil produced. There were sixteen shore stations – including two at Durban and one each at Cape Town, Saldanha Bay, and Plettenburg Bay – and eleven factory ships operating between the French Congo and East Africa.

After the Great War new techniques rendering whale oil edible brought enlarged markets while the design of factory ships with slipways for hauling whales aboard led to larger catches and over-whaling. Despite the depletion of stocks which followed, it was not until 1946 that an International Agreement limiting the annual catch was achieved. Meanwhile factory ships had largely replaced shore stations and whaling operations had become concentrated in Antarctic waters. During the war the two factory ships belonging to Union companies had been lost and the remaining shore stations at Durban and Saldanha Bay closed.

After the war these stations were reopened and a 'prize' ship acquired from the British Admiralty converted to the largest operating factory ship in the world. With its fleet of 36 catchers, formerly naval corvettes, this ship along with others, particularly Norwegian, Russian, and British, which provision at Cape Town, operates in both coastal and Antarctic waters until the ceiling of 16,000 Blue Whale Units has been taken.[9] On an average it produces between 140,000 and

160,000 barrels of whale and sperm oil annually, and in 1951 with an output of over 30,000 tons valued at £3 million set up a record for the Antarctic season.

The output at the shore stations has varied greatly. In the 1949–50 season over 83,000 barrels of whale oil and nearly 50,000 barrels of sperm oil were produced at Durban and nearly 40,000 barrels of whale oil and over 11,000 barrels of sperm oil at Saldanha Bay. In the following year the amount fell to about half.

Since the war South Africa with an output exceeding 40,000 tons has occupied third place, after Norway and the U.K., in the production of whale and sperm oil. Most of this is exported, only around 5,000 tons being used in the home margarine and soap industries.

In recent years, the complete processing of whales has resulted in the production of meat meal and bone meal for use in animal feeds and fertilizers. In addition it has been found that the livers of fin, Sei, humpback, and sperm whales and also the water in which whale meat is cooked contain B-group vitamins and essential minerals and the development of an extractive industry may be expected.

BIBLIOGRAPHY

1. W. H. STOOPS. 'The South African fishing industry'. *S.A. J. Econ.*, Vol. XXI, No. 3, 1953.
2. CECIL von BONDE. 'Fish and fisheries in South Africa'. *Industrial Development of South Africa, 1910–35*. Pretoria. 1936.
3. CECIL von BONDE. 'The South African fishing industry'. South Africa, United Kingdom, and Commonwealth Survey, 1954.
4. 'The fishing industry'. *The Overseas Reference Book of the Union of South Africa*, London, 1945, p. 324.
5. W. E. ISAAC. *Marine Biological Research and the South African Fishing Industry*. Res. Mem. Ass. Sc. Workers of S.A. No. 1. Cape Town. 1943.
6. P. SCOTT. 'Otter-trawl fisheries of South Africa'. *G.R.*, Vol. XXXIX, No. 4, 1949, pp. 529–51.
7. E. R. ROUX. 'Hake catch data from the West Ground'. *S.A. Sc.*, Vol. II, 1948–9.
8. 'The marine oils industry of the Union'. *Comm. and Ind.*, Vol. XII, No. 4, Dec. 1953.
9. Annual Reports of the Division of Fisheries.

Mineral Resources and Exploitation

49. Pure-bred Africander cattle for beef production on the natural red-grass (*Themeda triandra*) veld of the eastern Highveld near Ermelo. The eucalyptus trees have been planted both to provide shade for the animals and to act as a windbreak.

50. Fine Friesian dairy cows grazing lucerne in the Worcester district of the Cape. Here dairying is increasing as the farmers are turning to mixed farming. The eastern parts of the district are especially suitable, raising excellent lucerne. The birds are egrets or tick birds.

51. Merino sheep in the Karoo, a typical scene. The stacks in the background are of lucerne hay grown on the land behind. Note the wall built of stones cleared from the land used for cultivation.

52. Ostriches feeding on lucerne near Addo in the Sundays river valley. Although no longer of major importance ostrich farming is still carried on both in this valley and around Oudtshoorn in the Little Karoo.

53. Veld fire in the Humansdorp district of the southern Cape. The injudicious practice of burning the vegetation in order to promote the growth of succulent young shoots for sheep grazing has led to much veld deterioration, soil impoverishment and soil erosion in many parts of Southern Africa.

54. Erosion following deforestation and overgrazing in the Nkandhla area of Zululand. These slopes formerly carried forest similar to that shown in Plate 21. Without a protective vegetative cover to regulate the run-off the former stream courses have become deep gullies. The dark patches are the Native arable lands occupying the gentler slopes.

55. Severe sheet and gully erosion in the Bushveld near Rustenburg.

56. Extensive plantations of pine and eucalyptus trees clothing the eastern Highveld near Kaapsche Hoop where frequent mist (seen hanging over the plantations on the left) is favourable to tree growth. In the foreground typical Highveld sour grassland with indigenous forest occupying the kloof in the middle distance.

57. Typical South African west coast pilchard factory. In the background the Great Escarpment can be seen rising above the sandy coastal plain.

58. Whales caught by offshore whalers being taken up the slipway at Durban. In the background the Bluff.

59. The Big Hole at Kimberley which diamond diggers excavated as an open working to a depth of 1,335 feet before its bottom began to fill with water and its sides to cave in.

60. The Lichtenburg diamond diggings at the height of activity in 1929. The individual claims with their separate workings may be readily distinguished. (Published by permission of the Geological Survey of South Africa.)

61. Crown Mines, Johannesburg, showing the headgear of the main shaft and the reduction plant in the foreground and the dumps of waste material in the background. Crown Mines, with working levels over 9,000 feet below the surface, are the deepest mines in the world and up to the end of 1955 had yielded over 40 million fine ounces of gold; 25 per cent more than their nearest rival.

62. The Messina copper mine in the arid Limpopo valley. The ranges in the background are built of Primitive rocks which are more resistant to erosion than the Old Granite flooring the valley. Baobab trees (*Adansonia digitata*, Linn.), surviving from the savanna vegetation, may be distinguished in front of the ore treatment plant and by the house in the right foreground.

63. The Havelock asbestos mine situated in remote mountainous country in north-western Swaziland. The deposit was first worked in an open quarry (on the left) and then followed underground.

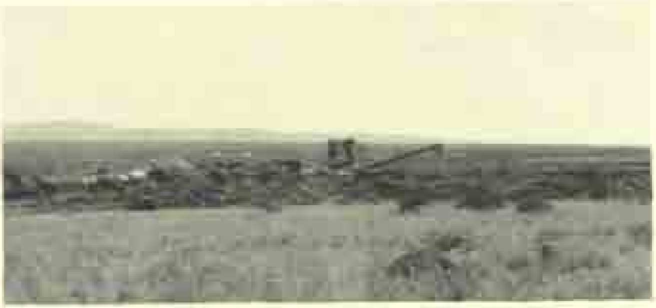
64. Typical Witbank colliery. The coal seams are approached not by a shaft but by a cutting seen disappearing into the ground (centre right).

65. The Highveld north of Vereeniging. The Klip River power station was originally a pit-head station and the colliery and conveyor to the power house (left) can be seen in front of the cooling towers (right). Behind are the old colliery tips. Coal now comes from Grootvlei colliery 41 miles away. A patchwork of arable and grazing lands typifies the Highveld. Irrigated vegetable lands below a small dam may be seen in the foreground.

66. The Sasol oil-from-coal plant. In the foreground are the cooling towers. Behind, left, is the Oxygen Plant and then the American Catalytic Synthesis Section and the Products Recovery Section. Behind, right, are the power station, the Gasification Plant and the German Catalytic Synthesis and Recovery Sections. In the background are the By-Products Section and the Storage Tanks.

67. The Iscor iron ore workings at Thabazimbi. Situated on a hill about 1,000 feet above the general surface level, they consist of tunnels and open-face quarries. The man hoist (emphasized by the white dotted line), carries the miners to the main adit. A self-acting incline (emphasized by the black dotted line) laid diagonally across the hill-side is used for conveying the ore to the railhead.

68. The Iscor iron ore workings at Sishen, Griqualand West. The ore is easily quarried from the Griquatown conglomerates which occupy sink-holes in the Dolomite underlying the level surface partially covered with Kalahari sand in the foreground. The Langeberge, of Matsap rocks, behind.



69. View southwards across the Iscor iron and steel works at Pretoria with in the background the Timeball Hill range with its iron ore quarries. The presence of iron ore reserves here was an important factor in the choice of this site for the first large iron and steel works in South Africa.

70. The Modderfontein explosives factory. In the foreground are the new ammonia and nitric acid plants. Parts of the explosives area can be seen on the right screened by trees. Centre is one of the five dams constructed along the Modderfontein river (tributary of the Jukskei) to provide water. Land irrigated for vegetables occurs below the dam on the far bank of the stream. Behind the dam are two housing estates.

71. The main factory of Lever Brothers (S.A.) (Pty) Ltd at Maydon Wharf, Durban. Originally depending on whale oil and imported vegetable oil and oil-seeds and tallow, the choice of this site was governed largely by the local whaling industry and by Durban's trade connexions with the East and with Australia, whence came the other raw materials.

72. The new factory of Lever Brothers (S.A.) (Pty) Ltd at Boksburg. The large buildings in the centre are stores for groundnuts and other oil-seed which come by rail (note siding), from the producing areas on the Springbok Flats and on the Highveld. Proximity both to the main sources of vegetable oil-seeds and to the Witwatersrand consumer market prompted the erection of this new works.

17

Introduction: Mineral Resources and Production

South Africa is richly endowed with a great variety of mineral resources. Some of these – copper, tin and iron ore – were worked by peoples inhabiting the country before the coming of the Europeans and formed important articles of trade. The Europeans found the copper deposits at O'Okiep as early as 1685 but for nearly two centuries they showed no further interest either in the discovery or in the exploitation of mineral wealth and the modern mining industry dates only from the discoveries of the latter part of the nineteenth century. Diamonds were discovered at Kimberley in 1870 and wealth derived from their exploitation provided the initial capital for the development of the Witwatersrand gold mines after the discovery of the banket in 1886. The market created by the gold mines provided the impetus for coal mining and later the development of the iron and steel industry, which in turn requires a variety of mineral raw materials. The present century has witnessed the discovery and exploitation of a number of metallic and non-metallic ores which yield minerals of vital importance in modern industry.

Ever since the latter part of the nineteenth century the South African economy has been based on the production and export of minerals. Mining taxation has supported agriculture and largely provided for the administrative and social needs of the State. The railway net has evolved in response to the needs of the mines and minerals form a major part of the freight carried today.

While industry is increasing in importance it is based essentially on mineral raw materials. The labour policy of the country is dictated largely by the requirements of the mines. Indeed the importance of the mineral resources and output of South Africa cannot be over-estimated from the national standpoint, while their economic and strategic significance to the western world is of tremendous and growing importance. From Table 10 the overwhelming value of the gold production and the overwhelming tonnage of coal production are apparent. The production of other minerals, however, has increased enormously during the past

Table 10. The Mineral Output of the Union of South Africa

	1928		*1938*		*1953*	
	Million tons	*£ million*	*Million tons*	*£ million*	*Million tons*	*£ million*
Gold (million fine oz.)	10·41		12·16	85·40	11·94	147·56
Platinum (million fine oz.)	0·02	0·22	0·03	0·22	0·26	6·07
Diamonds (million metric carats)	3·66	10·59	1·23	3·49	2·71	13·91
Coal	16·94	3·77	20·51	4·72	31·37	16·12
Iron Ore	0·04	0·01	0·55	0·13	2·17	1·15
Lime and Limestone					5·96	2·58
Manganese Ore	0·01		0·60	0·56	0·91	4·50
Chrome Ore	0·07	0·06	0·19	0·23	0·79	2·74
Nickel				0·007		0·68
Tungsten						0·17
Copper	0·01	0·72	0·01	0·46	0·04	9·27
Tin		0·24		0·09	0·003	0·96
Antimony					0·004	0·63
Asbestos	0·03	0·49	0·02	0·44	0·09	4·75

twenty years and today many of them have an importance out of proportion to the quantity and value of output. Today South Africa leads the world in the production of diamonds, gold, uranium, and platinum, is second to the U.S.S.R. in the production of manganese ore, is the leading source of antimony and chemical grade chrome ore and is an important supplier of metallurgical and refractory chrome. Although the total output is as yet small, she is a significant supplier of tungsten, nickel and beryllium in the western world. Together with South West Africa she is an important producer of copper, vanadium, and lead. The Union and Swaziland are exceeded only by Canada in the production of asbestos, while together with Southern Rhodesia they provide the bulk of the world's long spinning fibre. The reserves of coal and iron ore are among the largest in the world and the coal output is the largest in the southern hemisphere. The Union is an important exporter of corundum and vermiculite, while her production of a variety of other minerals is adequate for home needs.

Apart from coal, these vast mineral resources are the product of several periods of great igneous activity. Most important were those marked by the emplacement of the Old Granite and the Bushveld Igneous Complex. During the former auriferous lodes carrying subordinate quantities of silver, lead, copper, antimony and tungsten, were formed in the Primitive Systems of the Murchison range of the Transvaal Lowveld, and in South West Africa. At the same time deposits of corundum were formed at Leydsdorp and Pietersburg, apatite and vermiculite at Palabora and chrysotile asbestos in serpentine in Swaziland. The intrusion of the Bushveld Igneous Complex produced the largest mineral province

of its kind in the world. During the earlier basic phase of the norite emplacement magmatic differentiation resulted in the formation of huge sheet-like masses bearing platinum, chromite, and magnetite; these masses occupy horizons corresponding to pseudo-bedding planes and outcrop in more or less concentric rings around the rim of the Bushveld basin. In the succeeding acid phase of the intrusion of the Red Granite volatile compounds brought about the mineralization

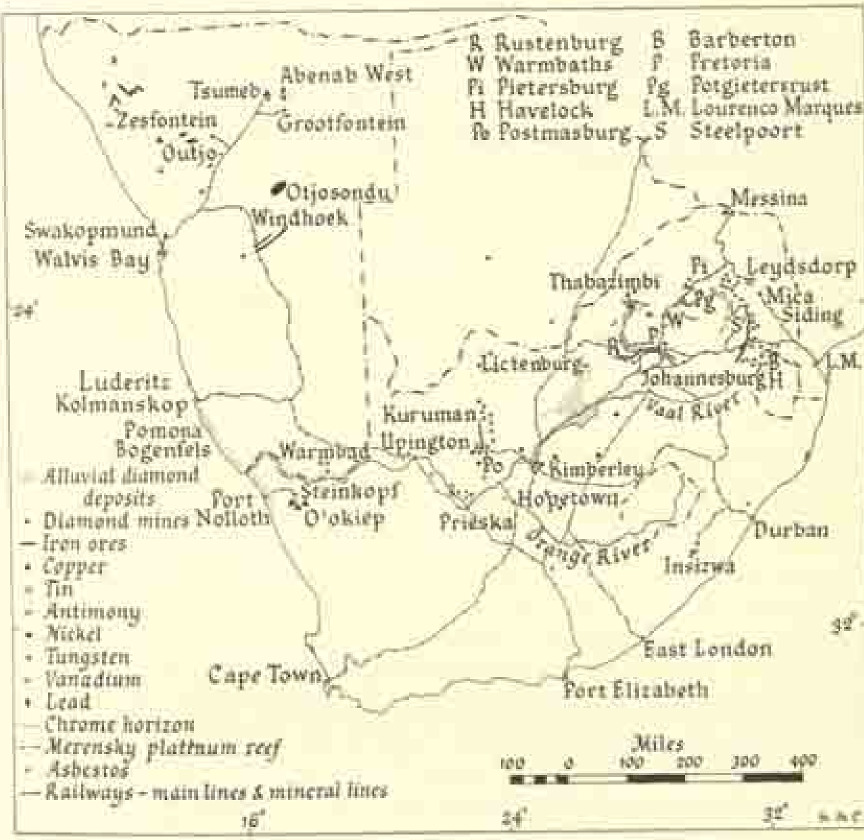


Fig. 98. The distribution of the more important mineral resources other than gold and coal.

(Note that manganese ores occur with the iron ores in the Postmasburg and Otjosondu areas.)

of the roof of the complex where ores of tin, tungsten, molybdenum, bismuth, copper, and arsenic, accompanied by fluorite, tourmaline, topaz, and monazite were deposited. Subsequently mineralization accompanying the post-Matsap earth movements brought about the formation of iron and manganese ore and amphibole asbestos in the Cape and Transvaal, igneous activity at the close of the Stormberg volcanicity produced the copper ores at Messina and, through

differentiation, the magmatic copper-nickel ores of East Griqualand, and finally a revival of magmatic activity at the end of the Cretaceous was responsible for the production of the multitude of kimberlite pipes in some of which diamonds are found. Apart from coal, the mineral resources are contained within the ancient rocks of the country which are found mainly in the Transvaal, the peripheral highland zone of South West Africa, and along the Griqualand–Transvaal axis of uplift in the northern Cape (see Fig. 98).

The various minerals produced may be grouped into four categories: (*a*) precious stones, (*b*) precious metals, (*c*) base metals, (*d*) non-metallic minerals. They will be considered in these groups with the exception of coal which will be given separate treatment and iron ore which will be dealt with in the section on the iron and steel industry.

18

Precious Stones

Diamonds

In 1867 the children of a Dutch farmer on the banks of the Orange river near Hopetown picked up what proved to be a 21¾ carat diamond to play with.[1] The recognition of this stone and the discovery, two years later, by a Griqua herd boy of the 82½ carat stone, which became the 'Star of South Africa', led to the first mineral 'rush' in South Africa. In 1870 some 50,000 people flocked to the Orange and Vaal river valleys where the search for diamonds was made in alluvial diggings along the river channels and dry water courses. In the same year, however, diamonds were found on the surface of volcanic pipes near Kimberley, which then became the centre of activity. These pipes subsequently became the sites of productive mines. The search for diamonds then extended all over Southern Africa, being directed towards the discovery of both further volcanic pipes and alluvial deposits. Between 1871 and 1890 seven pipes were located in the Kimberley district and some time before 1902 the pipe which now supports the Premier Mine near Pretoria was found. In 1908 a Cape Coloured 'boy' who had worked on the Kimberley mines picked up diamonds in the Namib desert east of Luderitz. This led to the discovery of the rich fields along the west coast of South West Africa at Kolmanskop, Pomona, and Bogenfels. Between 1925 and 1928 rich diamondiferous raised beach deposits were located along the coast of Namaqualand and in 1926 the diamondiferous gravels of the Lichtenburg Plain in the western Transvaal were found.

Mode of Occurrence and Methods of Mining

Diamonds are found in South Africa in three types of geological formation[2] – the conglomerates of the Witwatersrand System, the volcanic 'kimberlite' pipes of Cretaceous age, and younger alluvial gravels and boulder beds. The two latter sources only are of economic importance, and the diamonds found in the gravels and boulder beds are thought to be derived from the volcanic pipes. Very few diamonds have been recovered from the Witwatersrand rocks on the gold mines; their presence in such ancient rocks, however, lends support to the theory of

origin of the precious stones elsewhere, for the conglomerates in which they occur are considered to represent ancient alluvial or beach deposits in which diamonds derived from some older igneous mass, accumulated.

The mode of occurrence of the diamonds in the volcanic pipes and in the alluvial deposits has naturally occasioned different methods of exploitation. Each type of occurrence will therefore be considered separately.

The Volcanic Pipes

The volcanic pipes are filled with ultrabasic rock called 'kimberlite'; popularly known as 'blue ground' this weathers at the surface to 'yellow ground'. The diamonds are contained in this kimberlite. The pipes occur in groups over an area extending from Sutherland in the Cape Province to Mwanza in Tanganyika, the most important groups occurring at Kimberley, Pretoria, Jagersfontein, Koffiefontein, and Postmasburg. Of the 150 pipes so far discovered only 25 have contained diamonds in sufficient quantity to warrant mining and the bulk of the production has come from eight only. The pipes have the form of steep-sided funnels cutting nearly vertically through the country rock and tapering downwards. Varying greatly in size, their surface outcrop is usually ovoid. That of the largest, the Premier Mine, covers 78 acres with the major axis over half a mile long. Many, however, are less than 100 feet across.

The pipes were first worked by open quarrying which in some cases proceeded to great depths before mining became necessary. Most famous is the Big Hole at Kimberley (Plate 59) which was excavated as an open working to a depth of 1,335 feet before its bottom began to fill with water and the sides to cave in. Originally its outcrop, which covers 38 acres, was divided, chequer-board fashion, into individual claims which were worked at varying rates and to varying depths by their owners, but the increasing difficulties and dangers of working led to the amalgamation of interests into De Beers Consolidated Mines in 1888. This marked the beginning of systematic exploitation of the great pipes and led eventually to the development of an organization with virtual control over diamond mining in South Africa. The company subsequently worked the Bultfontein, du Toitspan, and Wesselton pipes near Kimberley to depths of 400 to 500 feet by open quarrying before resort was made to mining. The Premier mine, famous as yielding the world's largest diamond, the Cullinan of 3,024¾ carats – about 1¼ lb. – which was cut into a pendoloque and square brilliant for the royal sceptre and crown, was quarried to 600 feet, underground mining beginning only in 1949; and the Jagersfontein pipe was quarried to 800 feet. Today the more important pipes are worked by underground mining, vertical shafts being sunk some 1,000 feet from the boundaries of the pipes which are reached by cross drives. After mining, the kimberlite is crushed and washed and the heavy diamondiferous material separated. This is then treated in a pulsator and the diamonds finally recovered on grease tables.

Alluvial Deposits

Alluvial diamonds are found in gravels along the valleys of the Orange, Vaal, and Hartz rivers and also on the high Lichtenburg Plain. The distribution of the gravels in each case is intimately related to the drainage history.

Along the valleys of the Orange, Vaal, and Hartz rivers diamonds are found in the present river beds, in ancient gravel-filled channels, in terraces bordering the present rivers and in high-level gravel spreads up to 340 feet above and as much as 20 miles from the present streams. These gravels are thought to have been deposited by the present rivers which, however, shifted their courses laterally before becoming entrenched in their present valleys.

On the Lichtenburg Plain the diamondiferous gravels form low winding swells on the dolomite surface; they are thought to represent the remnants of deposits laid down by ancient streams flowing either to the Vaal or Molopo rivers[3] when the Dolomite was being denuded of the overlying Karoo beds and to owe their preservation to subsidence into solution hollows in the dolomite (see ch. 39, p. 611).

These alluvial deposits have been worked mainly by individual diggers who pegged their claims in massed foot races organized by the police. The valleys of the Orange and Vaal rivers were the scenes of the first activity but after 1911 diamonds were found in increasing numbers on the plains of the western Transvaal until in 1926 the very rich gravels of the Lichtenburg Plain were discovered (Plate 60). During the rushes which followed several thousand people pegged their claims. In the years 1927–8 the Lichtenburg diggings produced stones to the value of £7½ million. The richer gravels, however, have now been worked out and the population, which at the height of activity numbered about 50,000 Europeans and 90,000 Natives, has now dwindled to a few thousand, many of whom eke out a bare subsistence from their sporadic finds.

The Coastal Deposits of South West Africa and Namaqualand

Along the west coast of Southern Africa extremely rich diamond fields yielding gemstones of large size and exquisite quality occur in two very different types of deposit.

In the Namib desert between Luderitz Bay and the Orange river mouth diamonds are found in detritus occupying the floors of north–south troughs between bare rocky ridges. The detritus is largely derived from marine deposits and the concentration of diamonds has been effected by the south-south-westerly winds which blow strongly for many months of the year and sweep the finer material inland. The principal deposits are found at Kolmanskop, Pomona, and Bogenfels.

More important are the diamondiferous raised beach deposits found between the Orange river mouth and Alexander Bay and at Oranjemund north of the Orange river. These occur in wave-cut terraces and comprise marine gravels covered with some 30 feet of sand, surface limestone, and later gravels. The most

important terrace the 'Merensky Terrace' lies about 80 to 100 feet above present sea-level; two other terraces, at 60 feet and at 120 to 130 feet, have also been discovered. The maximum distance from the present shoreline at which they have been found is three miles. The Alexander Bay deposits are worked as the 'State Alluvial Diggings', those north of the Orange river are worked by a private company.

The Namaqualand diamonds are the finest gemstones so far found in South Africa. Their origin is uncertain but in the Buffels river valley diamonds have been traced upstream to kimberlite pipes which are considered to be the most likely source.[8]

Generally speaking the recovery of diamonds from these coastal deposits is easier and less costly than from the kimberlite pipes. Modern machinery is used to strip the overburden and excavate the diamondiferous gravel from the raised beach deposits. The gravel is then sorted and washed and the diamonds recovered in electro-static separators, the use of grease tables being ruled out owing to the presence of microscopic encrustations of salt which make the diamonds non-water repellant. The exploitation of these fields, however, has been attended by considerable difficulties with regard to water supplies and transport. Before 1949 all supplies to the area north of the Orange river had to be hauled 180 miles from the nearest railhead at Kolmanskop. Since 1949, however, the completion of a low-level bridge across the Orange has permitted supplies to be brought in from Port Nolloth. Water is pumped from the Orange river, power comes from a diesel electric plant at the Orange mouth (but transmission is rendered difficult because the dense salt fog rusts the metalwork which further suffers corrosion from the sand blast), and foodstuffs are produced under irrigation on a farm, owned by the operating company, along the Orange river.

Production, Markets, and Prices

Between 1883 and 1952 diamonds valued at over £425 million were produced in the Union and between 1911 and 1952 diamonds valued at nearly £70 million were won in South West Africa. In both territories the yearly output has fluctuated considerably as a result of the discovery and exploitation of new fields and as a response to world market conditions (see Fig. 99). Prior to the market collapse of 1930 when overproduction consequent upon the opening of the Lichtenburg, Namaqualand, and South West Africa fields coincided with the onset of the Great Depression, the need for control over output to ensure that prices are sufficiently high to meet the costs of production had not been fully recognized. However, the De Beers Company, which had acquired control over the Kimberley, Free State, and Premier mines, and had set up the Diamond Corporation as selling organization, was sufficiently strong to buy up large quantities of diamonds for sale over a long period. At the same time it closed its own mines. Operations continued on the alluvial diggings where the costs of production were lower. The Union Government operating the State alluvial

diggings recognized the need for control over output but, anxious to ensure a regular supply of stones to the home diamond cutting industry which it was fostering, refused to sell through the Diamond Corporation. Eventually in 1934, however, a Diamond Producers Association, embracing all the leading producers, who agreed to the apportionment of trade by means of quotas, was formed and

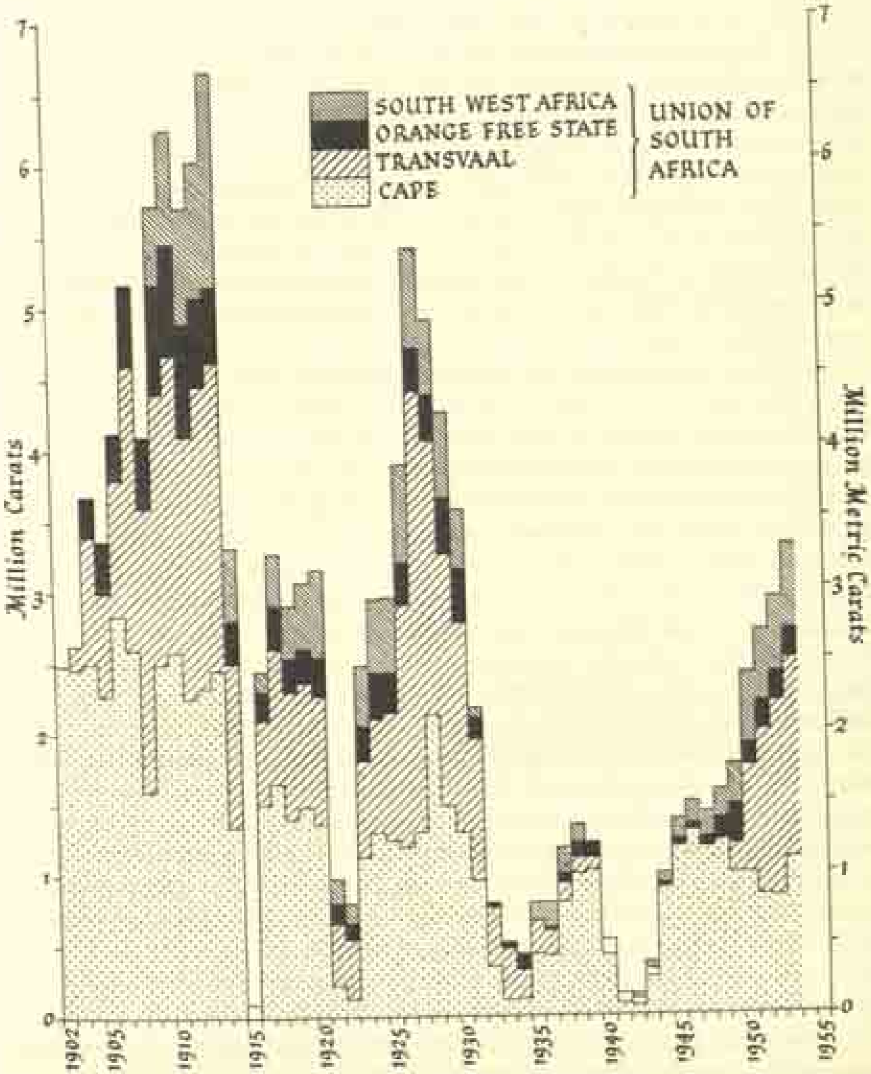


Fig. 99. The diamond production of the Union of South Africa and South West Africa, 1902–53.

(Note the unshaded columns show the output of the Union other than that shown by individual provinces. Production 1902–21 in carats, 1922–53 in metric carats.)

set up its own selling agency – The Diamond Purchasing and Trading Company. Thereafter the position improved and mining was resumed on a limited scale at the Kimberley mine in 1935, at du Toitspan and Jagersfontein in 1936, and at Koffiefontein in 1937. Production on these mines increased gradually until the outbreak of war caused the cessation of activities.

Before 1939 diamonds had been in demand mainly as gemstones for the jewellery trade. The allied war effort, however, brought an unprecedented demand for industrial diamonds for use in cutting tools and machinery where extreme hardness and toughness are required. To meet this need industrial diamonds were exempted from the quota system in 1943, and to supplement the output from the Belgian Congo, the main source of industrial diamonds, the du Toitspan and Bultfontein mines were re-opened in 1943 and 1944 respectively. Apart from a temporary slackening in world demand immediately after the war, the market for industrial diamonds has continued to expand. In response to this the Premier Mine, reorganized and re-equipped as an underground working, and the Jagersfontein mines, both noted for the excellence of their industrial diamonds, were reopened in 1949.

Since the war gemstones have been eagerly bought particularly in the U.S.A. which takes over 80 per cent of the world's diamonds. The prospects for the diamond mining industry are thus bright. South Africa, however, is no longer in the happy position of having practically a world monopoly in the supply of diamonds. Production has increased in other parts of the world, notably Angola, the Belgian Congo, the Gold Coast, and more recently Sierra Leone, until today their total output exceeds that of the Union. It consists, however, mainly of industrial diamonds, and sales are regulated by agreement between the South African and outside producers. In 1951 the net sales of gemstones was nearly £47 million while industrial diamonds realized over £18 million. Of the total the Union accounted for over £14 million and South West Africa more than £8½ million, both figures being records.

Today, except on a few farms, precious stones are the property of the State. Formerly the discovery of payable alluvial deposits led to the proclamation of the ground as public diggings, after the owners and the discoverer's rights had been secured, but the over-production of the Lichtenburg fields prompted legislation in 1927 enabling the Government to permit or prohibit the prospecting and working of diamonds both on private and Crown land and to control the disposal of the diamonds won. In Namaqualand apart from several discovery claims that have been granted the Government retains full possession of all diamonds on Crown reserves, and operates the fields as State diggings.

Thus from being in the hands of innumerable diggers diamond mining has passed to the control of a few large producers who are able to regulate the output.

BIBLIOGRAPHY

1. Union of South Africa, Dept of Mines, Geological Survey. *The Mineral Resources of the Union of South Africa*, Pretoria, 1940, p. 79.
2. See P. A. WAGNER. *The Diamond Fields of Southern Africa*. Johannesburg. 1914.
3. J. H. WELLINGTON. 'The Vaal–Limpopo Watershed'. *S.A.G.J.*, Vol. XII, 1929.
4. H. MERENSKY and P. WAGNER. 'The diamond deposits of Little Namaqualand'. *T.G.S.S.A.*, Vol. XXXI, 1928.

19

Precious Metals

Gold

Although gold had been known and worked on the African continent from very early times (see ch. 5, p. 99) it was not until the late nineteenth century that the great goldfields of the Transvaal were found. The first European discovery of gold was actually made in 1853 when unpayable quantities were found in the Jukskei river a few miles north of where Johannesburg now stands. Over thirty years elapsed, however, before the discovery of the Witwatersrand goldfield for prospecting focused on the Old Granite and the Primitive rocks of the northern and eastern Transvaal. Here gold was found in the Murchison range in 1870, near Pietersburg in 1871 and at Pilgrims Rest in 1873.[1] The de Kaap goldfields were opened in 1882 and three years later the rich Sheba reef was discovered and Barberton founded. These discoveries encouraged prospecting all over South Africa. In 1884 gold was found on the Witwatersrand and a year later came the momentous discovery of the banket which made South Africa the world's leading gold producing country. Johannesburg was founded in 1886 and the next year when the first stamp mill working the banket came into operation, the Chamber of Mines was formed to protect the interests of the new industry. Thereafter the Witwatersrand goldfield was developed rapidly and in a planned and scientific manner,[2] while the other gold-producing areas became relatively insignificant.

After the discovery of the Witwatersrand goldfield, gold became the dominant export and gold taxation the main source of revenue first of the Transvaal republic and later of the Union of South Africa. Gold has, in fact, very largely financed the economic development of South Africa and even today still forms the backbone of the economic life. The continued prosperity of the industry is, therefore, of tremendous national importance. Already the industry has experienced several vicissitudes occasioned by world economic conditions and/or internal difficulties. The Anglo-Boer War interrupted the development of the field in the early days, but subsequently the changed political set-up, particularly after Union, promoted progress. Output dropped during the first world war and

the period of labour troubles which followed but after 1922, apart from a temporary decrease in output associated with the mining of low grade ore after the abandonment of the gold standard in 1932, production increased steadily to a maximum in 1941 (Fig. 100). Soon after, however, wartime conditions and rising production costs, while the price of gold remained fixed, caused a decline. This

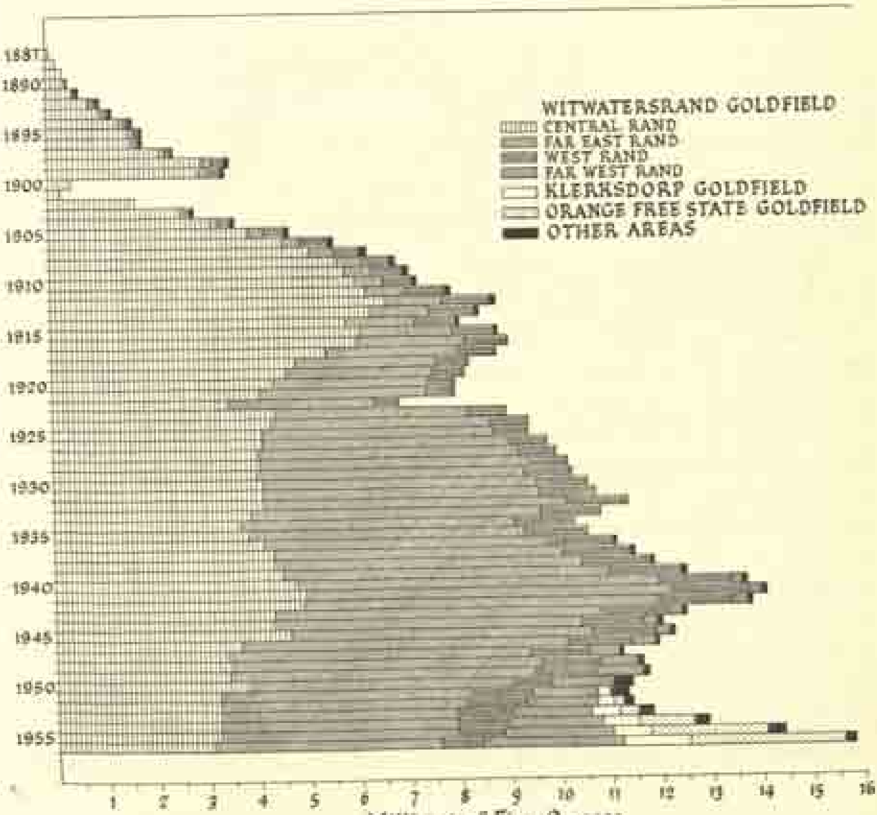


Fig. 100. The gold production of the Union of South Africa and of the leading goldfields, 1887–1956.

(Compiled from data given in the annual reports of the Transvaal Chamber of Mines and the Transvaal and Orange Free State Chamber of Mines.)

was only arrested by the devaluation of sterling in 1949, bringing an increase in the price of gold.* Since then the output has increased (Fig. 100) although production costs have continued to rise. Today many of the older mines on the Witwatersrand are approaching exhaustion and although the field is likely to remain an important producer of gold for some 25 to 30 years a steady decline in

* The rise in the price of gold was from 172*s.* 6*d.* to 248*s.* 3*d.* per fine ounce.

its output is inevitable. Meanwhile two new goldfields – the Orange Free State goldfield and the Klerksdorp goldfield (see Fig. 101) – have recently come into production and their output will steadily increase. In addition gold has been found in a fourth area, along the railway line between Leslie and Trichardt in the

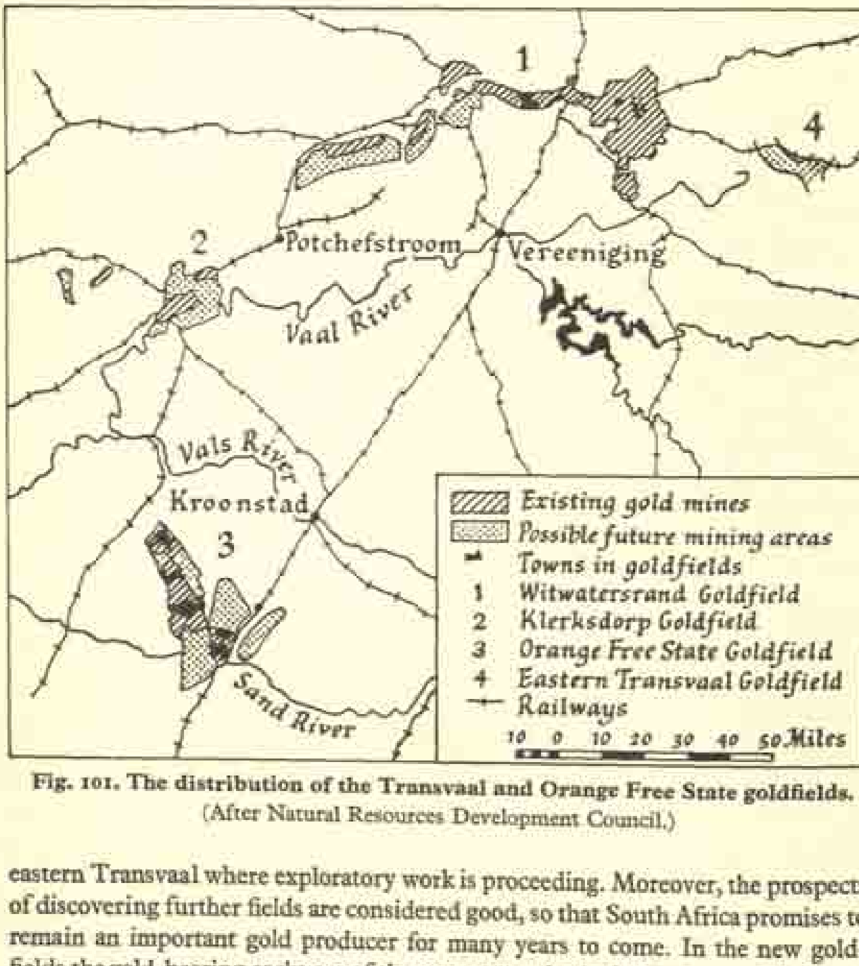


Fig. 101. The distribution of the Transvaal and Orange Free State goldfields.
(After Natural Resources Development Council.)

eastern Transvaal where exploratory work is proceeding. Moreover, the prospects of discovering further fields are considered good, so that South Africa promises to remain an important gold producer for many years to come. In the new goldfields the gold-bearing rocks are of the same age as in the Witwatersrand field and indeed all the fields belong to the same geological province.

The Geology of the Witwatersrand, Klerksdorp, and Orange Free State Goldfields

The Witwatersrand and neighbouring goldfields differ from all other goldfields in the mode of occurrence of the gold and in the remarkable continuity of the gold-bearing rocks over considerable areas. It is these features which have sup-

ported a large-scale gold mining industry and have sustained it over a long period of time – already more than seventy years. They have also greatly facilitated both exploratory and developmental work on the Witwatersrand, where the rocks outcrop, and promoted the discovery of the concealed field of the Orange Free State. Attention must therefore be given to the structure of the gold-bearing areas and to the nature and distribution of the gold-bearing rocks.

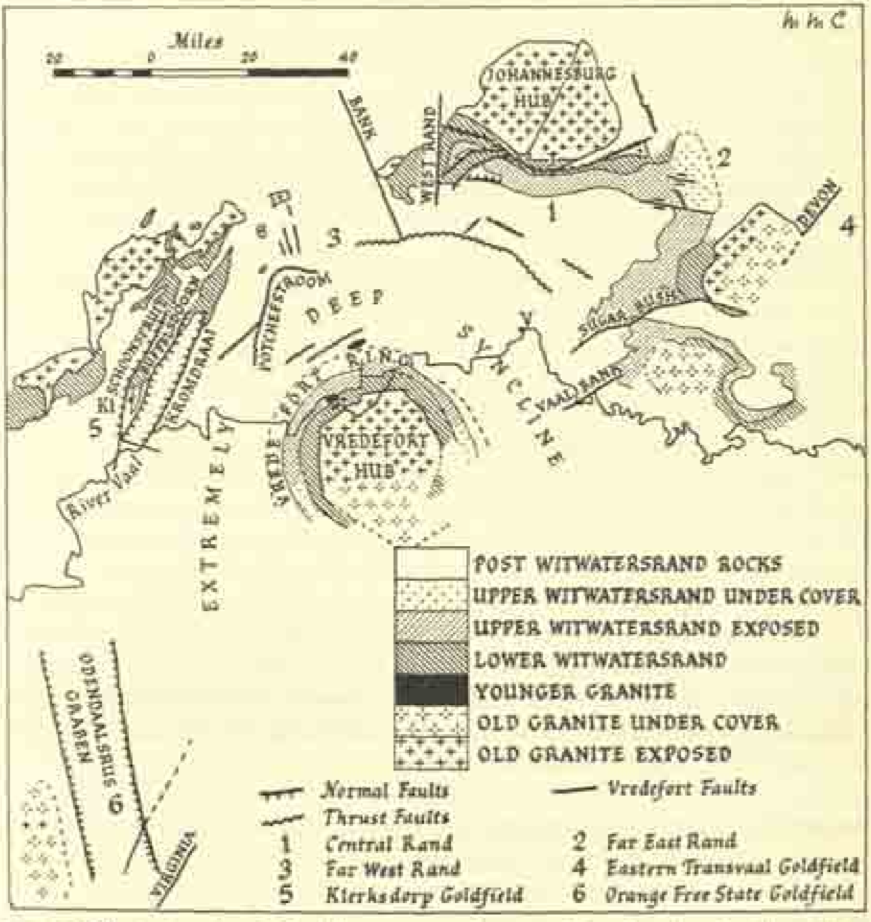


Fig. 102. Tectonic plan of the Witwatersrand geosyncline showing the disposition of the main goldfields and their relationship to the masses of Old Granite.
(Adapted from B. B. Brock.)

The gold occurs in the upper division of the Witwatersrand system of rocks. The system as a whole occupies a trough-like area between Old Granite masses to the north and south (Fig. 102). The rocks outcrop only in the Central Witwatersrand, between Heidelberg and Springs, north of Klerksdorp and in the vicinity of

the Vredefort dome. Elsewhere they are concealed by considerable thicknesses of younger rocks. They were originally laid down horizontally (see ch. 1, p. 6) but the subsequent uplift of the granite masses has given them a steep dip at the margins of their outcrop and occasioned faulting both here and within the series. This has led to the preservation of the economic horizons in some localities but not in others and determined the actual goldfields. So far three major goldfields are known and a fourth is being explored. Most important is the Witwatersrand field which is partly exposed at the surface and partly concealed. It occupies the centre of the original area of deposition but contains within it a barren upthrown area between the Witpoortje and Roodepoort faults. The Orange Free State goldfield occupies a depression in which the gold-bearing reefs are preserved, which has been described by one authority as a rift valley[3, 4] and by another as a wedge-shaped syncline much affected by block faulting. The Klerksdorp field occupies another depression resembling a rift valley bounded by horst-like blocks of barren rocks.

Within the upper division of the Witwatersrand System[5] the gold occurs in a very finely divided state in 'reefs' – thin bands of quartz-pebble conglomerates called *bankets*. These reefs occupy a characteristic position at the base of sedimentation cycles (see ch. 1, p. 6) and are considered to represent old shoreline pebble deposits in which particles of alluvial gold and other heavy minerals became concentrated by wave action during the advance of the sea front. Hence their continuity as relatively thin horizons over great distances today, the orientation of the long axes of the pebbles parallel to the postulated shoreline, and the occurrence within the reef of richly auriferous lenticular bodies known as 'pay-streaks' similarly oriented. The most important gold-bearing reefs are contained in the Main-Bird Series of quartzites and conglomerates which occur at the base of the upper Witwatersrand Division and are remarkably continuous over a wide area. At a variable distance above is the Kimberley–Elsburg Series which is somewhat less important. The Upper Witwatersrand rocks attain their maximum thickness of about 9,000 feet near Johannesburg on the central Witwatersrand. Here the Main-Bird and Kimberley–Elsburg Series with their gold-bearing reefs are also most fully developed. The succession thins towards the Far East Rand, and the Klerksdorp and Odenaalsrus areas (Fig. 103). Although the gold-bearing horizons are remarkably continuous over large areas, nevertheless within the Main-Bird and Kimberley–Elsburg series the individual reefs show some variation in continuity of development, thickness and productivity, and spacing one from another over comparatively short distances. On the Witwatersrand by far the most important reefs occur in the Main Reef group[6] and comprise in ascending order the North Reef, Main Reef, Main Reef Leader, Middle Reef, and South Reef. The Main Reef with an average thickness of about 5 feet is the most strongly developed but, owing to the presence of thin quartzite partings is less productive than the slightly thinner Main Reef Leader. The South Reef is thinner and poorer in gold while the Middle and North Reefs, usually less than

two feet thick, are relatively unimportant, except on the Far West Rand where the rich Carbon Leader represents the North Reef. On the Far East Rand the several reefs merge to form a Composite Reef. Associated with the Main Reef group are banded pyritic quartzites, which underlie the Main Reef Leader on the Central Rand and the Main Reef on the Far East Rand and are known as the Footwall Reef, and the Upper Leaders. Both yield gold locally. The other reef groups, which include in ascending order the Johnstone, Livingstone, Bird, Kimberley,

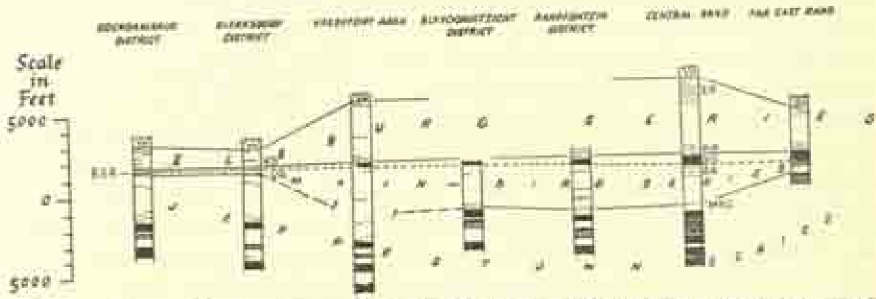


Fig. 103. Generalized sections through the Upper Witwatersrand System and the Jeppestown Series of the Lower Witwatersrand System to show the relationship of the Reef horizons in the several Transvaal and the Orange Free State goldfields.

ER, Elsburg Reefs. KR, Kimberley Reefs. KS, Kimberley Shales. BR, Bird Reefs. MRG, Main Reef Group. VR, Vaal Reef. BSR, Basal Reef.

and Elsburg reefs are generally very low grade and of minor economic importance. In consequence of the thinner succession in the Klerksdorp and Odenaalsrus areas fewer gold-bearing reefs are present. Opinion is divided on the correlation with those of the Witwatersrand, but the Vaal reef of the Klerksdorp area and the Basal reef of the Odendaalsrus area have been correlated with the Main–Bird reefs of the Witwatersrand area with recent work favouring the actual correlation with the Main Reef horizon rather than, as hitherto suggested, with the Bird reef (Fig. 103). The B reef of the Odendaalsrus area is thought to occupy the same horizon as the Kimberley reef to the north and east.

The Witwatersrand Goldfield

Extent

The Witwatersrand goldfield extends for 50 miles from Randfontein eastwards to Springs, for 20 miles from Springs southwards to Heidelberg and for 40 miles from Randfontein south-westwards to the Mooi river. Structurally it may be divided into four main regions. On the Central Rand from Roodepoort to Boksburg the Upper Witwatersrand sediments outcrop in a trough-like depression south of the series of parallel ridges formed by the Lower Witwatersrand quartzites. To the east they thin out and pass beneath a cover of younger rocks (see Fig. 104) to form the shallow basin of the Far East Rand. The West Rand

resembles the Central Rand, from which it is separated by the barren upthrown area between the Roodepoort and Witpoortje faults, in the surface exposure of the upper Witwatersrand sediments. To the south-west of Randfontein, however, on the Far West Rand the sediments are overlain by dolomite.

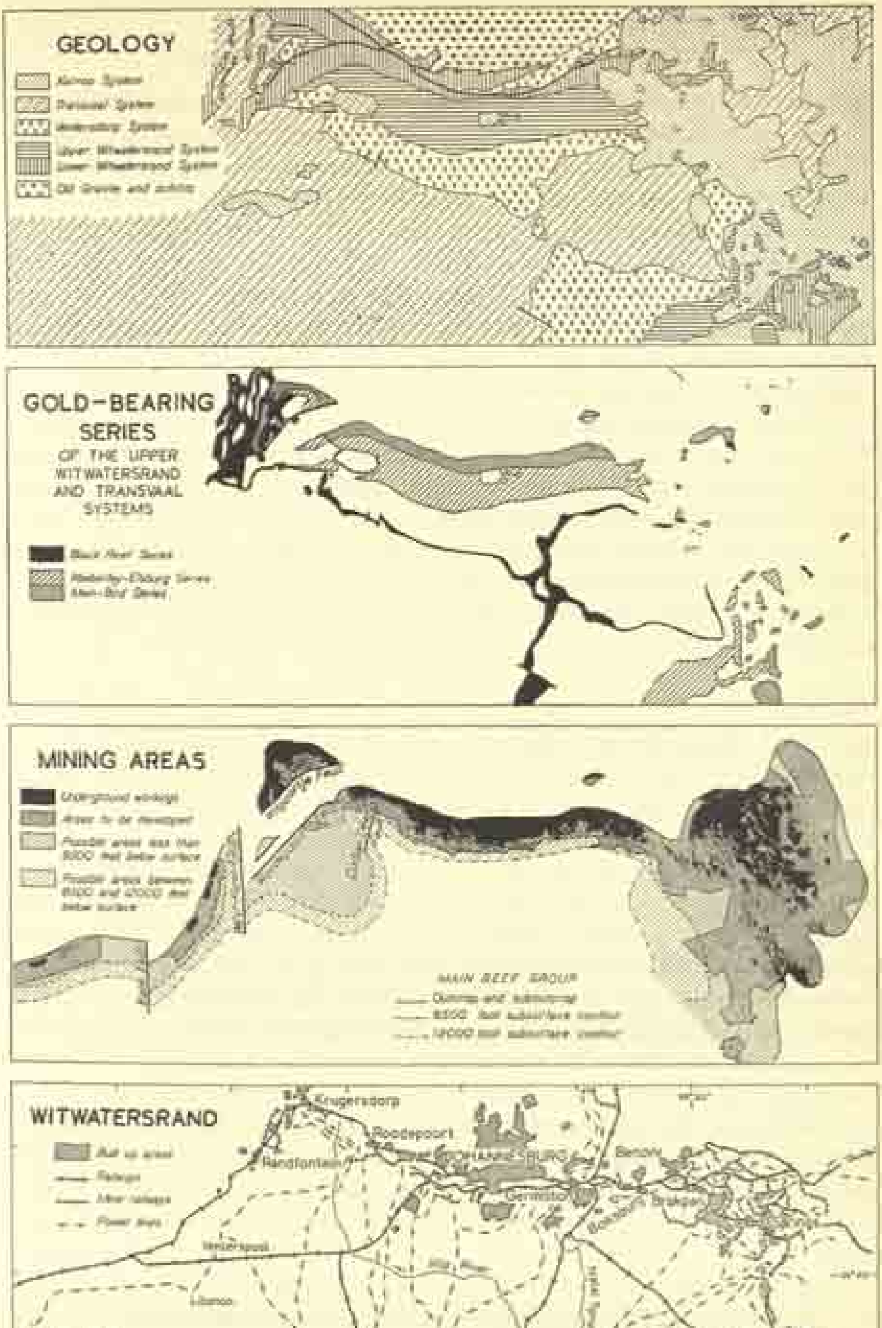
Geology

The mining conditions vary between the several regions. On the Central Rand the reefs dip southward at about 60° near the outcrop and flatten out in depth to about 30°. Generally speaking the sediments are uniform in character and little disturbed but normal and reverse faults with small displacements are frequent. In order of importance the chief reefs mined have been the Main Reef Leader, the South Reef, the Main Reef, the Middle Reef, and the North Reef. Westwards from the Robinson Deep mine the Main Reef Leader becomes thinner and finally disappears near the Roodepoort fault. Eastwards from the Witwatersrand Deep mine the reef horizons of the Main Reef group merge to form the Composite Reef. Within the conglomerate zones of this group the gold occurs in rich 'pay-streaks', up to 1,700 feet long and 450 feet wide.[7] The Main Reef group has been of outstanding importance as a gold producer but in addition all the higher reefs, except the Livingstone Reef, have, despite their low grade, been worked. The great thickness of the gold-bearing series on the Central Rand has led to very deep level mining in this region. Already two mines are working at depths exceeding 9,000 feet, air-cooling and ventilation plant being used to reduce the excessive temperatures.

By contrast the gold-bearing reefs of the Far East Rand basin are nowhere below 6,000 feet.[8] On the northern flank the dips are less than on the Central Rand and in the central areas the strata is nearly horizontal. Except on the south-eastern flank, only minor faults occur. Until 1932 only the Main Reef or Composite Reef was worked but since then the Footwall Reef, Upper Leaders, the Livingstone Reefs, and especially the Kimberley Reef have been mined in the northern area. The Main Reef is notable for the frequency, richness and size of the 'pay-streaks' which fan out near Benoni and may be up to 4,600 feet long and 1,000 feet wide.

On the Far East Rand the Upper Witwatersrand sediments are overlain by Dolomite and by Coal Measures. While the latter, by yielding fuel, building stone and the raw materials for firebricks, have aided mining development, the former, particularly where intruded by dolerite dykes of post-Karoo age, has made shaft sinking difficult and dangerous owing to the risk of flooding from water-bearing cavities and the danger of rock disintegration along joints.

Generally speaking conditions in the West Rand resemble those on the Central Rand. The region is delimited by the outcrop of the steeply dipping Main Reef group on the north and west and by the Witpoortje fault on the south-east.[9] To the south and west there is an increase in the thickness of the Upper Witwatersrand series, in the number of reef groups and in the thickness and gold



Figs. 104–7. The Witwatersrand goldfield; geology, mining areas, towns, communications and power lines.

(After P. Scott, courtesy of the *Geographical Review*.)

content of the individual reefs, and in the productivity of the mines. Everywhere the Main, South, and Kimberley Reefs are most important, but the Johnstone, Livingstone, and Bird Reefs, as well as the Contact Reef at the junction of the Elsburg Series and overlying Ventersdorp lavas, and the Black Reef of the Transvaal system, have been worked in some mines.

The Far West Rand resembles the Far East Rand in the overlay of water-bearing Dolomite which hampered prospecting prior to 1930. The region is now known to extend for nearly 40 miles from the West Rand or Venterspost fault to the severely faulted zone marked by the Bank fault near the Mooi river. The Witwatersrand rocks are reached at between 1,400 and 4,000 feet below the surface in the east and between 2,500 and 3,700 feet in the west.[10] In proximity to the Venterspost fault the reef succession is similar to that on the West Rand but the number of reefs decreases westwards until at Blyvooruitzicht the succession resembles that on the Central Rand. In the east, where the beds dip at about 40° south-eastwards the Main Reef is the most important while in the west, where the beds dip southwards at 25° the Carbon Leader is the only one mined. Here the possibility of working this horizon at depths exceeding 8,500 feet is being investigated.

Gold Production

Of the 523 million ounces of fine gold produced on the Witwatersrand from 1887 until the close of 1955, the Central Rand had contributed 46 per cent, the Far East Rand 42 per cent, the West Rand 9·5 per cent, and the Far West Rand 2·5 per cent. During this period the relative importance of these producing areas varied. Mining began on the outcrop of the Central Rand which retained a dominant position until 1923 (Figs. 108 to 111). Until 1911 the West Rand held second place, contributing a small output, but thereafter production increased rapidly on the Far East Rand which in 1923 outstripped the Central Rand[11] and has maintained the lead to the present day. Since 1940 production has increased rapidly on the Far West Rand overtaking that of the West Rand in 1951.

Between 1887 and 1897 production was virtually confined to the Central Rand (see Figs. 108 and 109). At first trenches, seldom more than 50 feet deep,[12] were dug along the outcrop, but in 1888 the first inclined shafts were sunk and underground mining began. Subsequently, favourable borehole results, indicating the continuity of the reefs at depth, led to the establishment of deep level mines to the south. By 1897 the deepest shaft, that of the Robinson Deep, one mile south of the outcrop, was down to 2,400 feet.[13] The development of underground mining was greatly facilitated by the discovery of coal near Boksburg in 1887 and at Brakpan and Springs in 1888 (ch. 22), by the opening of the local railroad connecting Johannesburg with Boksburg in 1890 and with Springs and Krugersdorp in 1891, and by the completion of the trunk railways from Cape Town, Lourenço Marques, and Durban between 1892 and 1895, thereafter available for bringing in imported machinery and supplies.

Difficulties, however, were experienced. With deeper mining working costs increased while, owing to the pyritic nature of the ore from the deeper levels, gold recovery, which until 1890 was by amalgamation, fell from 74 per cent to 60 per cent. Fortunately at this stage the MacArthur–Forest Cyanide process, giving a recovery of 75 to 95 per cent, was introduced and after 1892 generally adopted.

Water supplies too were a problem. In the early years wagon loads of ore were sometimes carried across Johannesburg to stamp mills located on the Jukskei river. Occasionally after prolonged droughts crushing was held up for want of water. Most of the early stamp mills favoured the valleys of the Klipspruit and Natalspruit across which small dams were built for water storage but as mining moved southwards it became necessary to sink wells and boreholes to tap the underground water supplies of the Dolomite.

Table 11. Average Number of Employees on the Rand Gold Mines, 1898–1948

	1898	*1908*	*1918*	*1928*	*1938*	*1948*
Europeans	9,000	17,593	22,632	21,341	38,021	36,403
Natives	88,411	140,304	179,276	194,538	298,552	271,399
Chinese		21,027				
All Races	97,411	178,924	201,908	215,879	336,573	307,802

The provision of adequate labour was a further problem which was met by the employment of skilled European miners, mainly from Cornwall, who were engaged on a permanent basis and of unskilled Natives (see Fig. 116), mostly from Mozambique, who came for short periods only. The supply of Natives, however, was generally inadequate. Hence in order to organize recruitment in Mozambique and Nyasaland, the Chamber of Mines, in 1893, appointed a Native Labour Commissioner, whose functions were taken over and extended by the Witwatersrand Native Labour Association in 1896.

Table 12. Origin of Natives Employed in Rand Gold Mines, 1898–1948

	1898 (%)	*1908* (%)	*1918* (%)	*1928* (%)	*1938* (%)	*1948* (%)
South Africa	23·4	39·1	55·6	64·4	50·6	39·1
Mozambique	60·2	54·9	34·6	24·3	25·5	36·7
Basutoland	11·1	3·1	5·5	7·1	14·3	13·2
Bechuanaland	3·9	0·8	1·1	1·2	3·2	3·5
Swaziland	0·9	1·0	2·1	2·1	2·3	2·5
Other Territories	0·5	1·1*	1·1*	0·9	4·1†	5·0†

* Mostly Southern Rhodesia. † Mostly Nyasaland.

In 1898, the output of the Witwatersrand gold mines reached 3,564,581 fine ounces, more than one-quarter of the world production, but in the following year the outbreak of the South African War disrupted the industry and the same level

of production was not achieved again until 1904. Thereafter the structure of the industry was reorganized. Because of the number and richness of the reefs and relative ease of mining, the Central Rand remained the centre of the industry while the difficulties of shaft sinking through the Dolomite hampered development on the Far East and Far West Rand. On the Central Rand the amalgamation of adjoining properties brought about the elimination of the small independent producers while the advent of large mines,[14] which in 1911 numbered 51, under the control of large companies associated in mine corporations or 'groups' for the pooling of technical and financial resources, greatly facilitated deep-level mining. This was further aided by the development of the Witbank coalfield (see ch. 22, pp. 354–9) affording superior and more cheaply mined coal than the East Rand field, and by the provision of electricity supplies (see ch. 23). By 1911 there were two rows of producing mines (Fig. 110), one line working at depths of 1,000 to 2,500 feet and another to the south working at depths of 2,500 to 4,500 feet.[15] At this stage the electrification of hoisting machinery by permitting the replacement of direct hoisting, using steam power, by stage hoisting and the installation of machinery underground made possible mining at depths greater than 4,500 feet. By 1911 most mines had become electrified and the stage was set for an advance in depth.

Labour, however, remained a problem. The acute shortage of Native workers after the South African war led, in 1904, to the introduction of indentured Chinese Coolies under a scheme providing for compulsory repatriation. By 1906 52,000 of them were employed but so strong was the feeling against them that their repatriation began in the following year and was completed by 1910. By this time the supply of Native workers was increasing while the replacement of the old hand drills by reciprocating machine drills driven by compressed air supplied by local power stations (see ch. 23) reduced the labour required per ton of ore milled. At the same time the tube mill which re-grinds the coarse mill product and permits a higher recovery rate, was introduced. Because the machine drills could be used only in the wider and generally less productive slopes, however, the rate of recovery fell. Nevertheless, by 1912 the annual production reached 8,833,847 fine ounces representing 39 per cent of the world output. The Central Rand contributed 6,670,854 fine ounces of this total, an all-time record for the region.

Table 13. Average Number of Employees on the Rand Gold Mines per Thousand Tons of Ore Milled, 1898–1948

	1898	*1908*	*1918*	*1928*	*1938*	*1948*
European	1·2	1·0	0·9	0·7	0·7	0·7
Natives	12·1	8·8	7·6	6·4	5·5	5·0
All Races	13·3	9·8	8·5	7·1	6·2	5·7

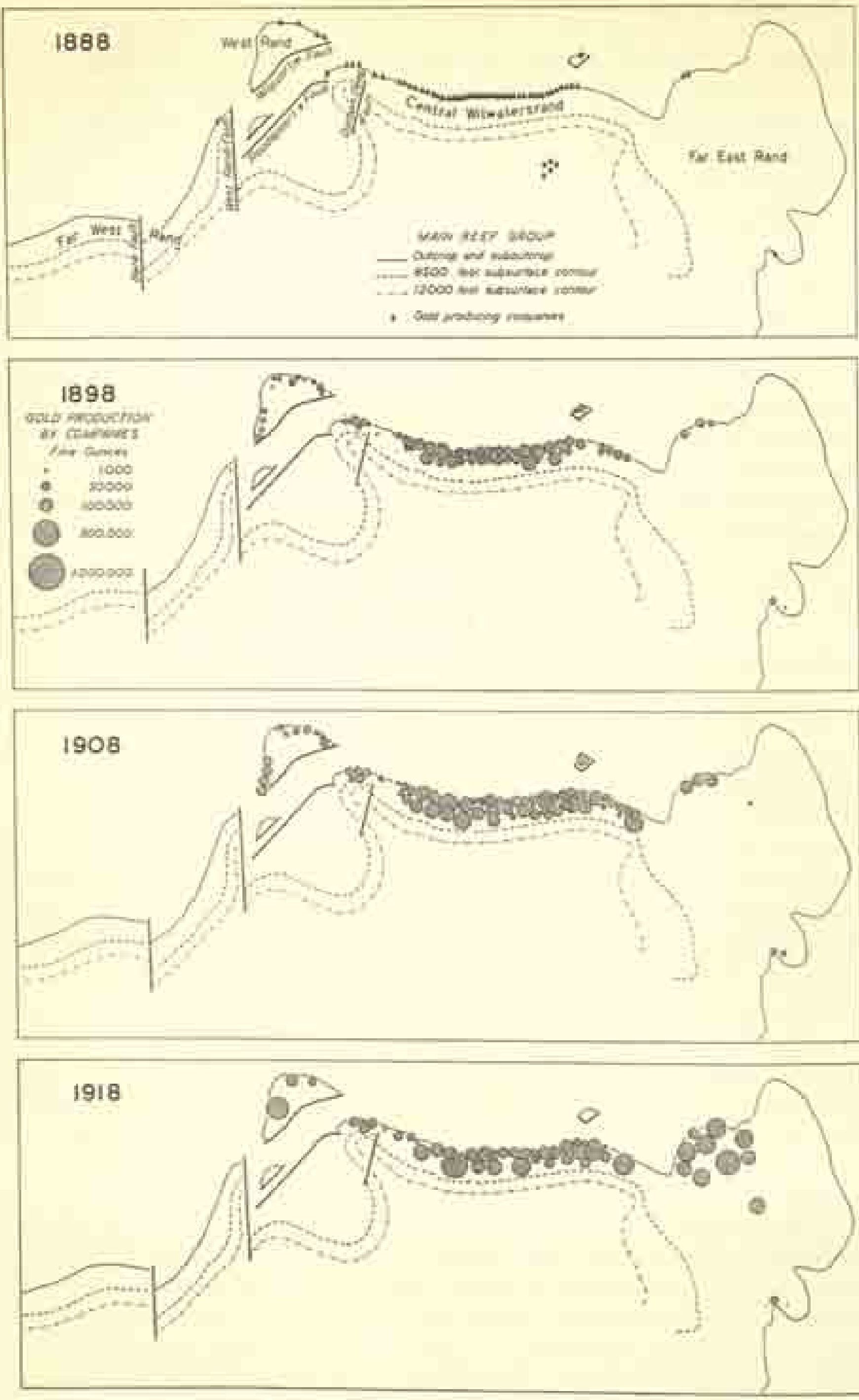
Table 14. Gold Recovery on the Witwatersrand, 1898–1955 in Dwts. per Ton Milled

	1898	1908	1918	1928	1938	1948	1955
Witwatersrand	9·78	7·46	6·61	6·71	4·35	4·01	4·27
Central Rand	10·09	7·50	6·00	5·76	4·05	3·68	3·45
Far East Rand	8·11	7·75	8·62	8·40	5·00	4·64	3·93
West Rand	8·21	6·68	5·26	4·69	3·54	3·00	1·98
Far West Rand						7·82	8·74

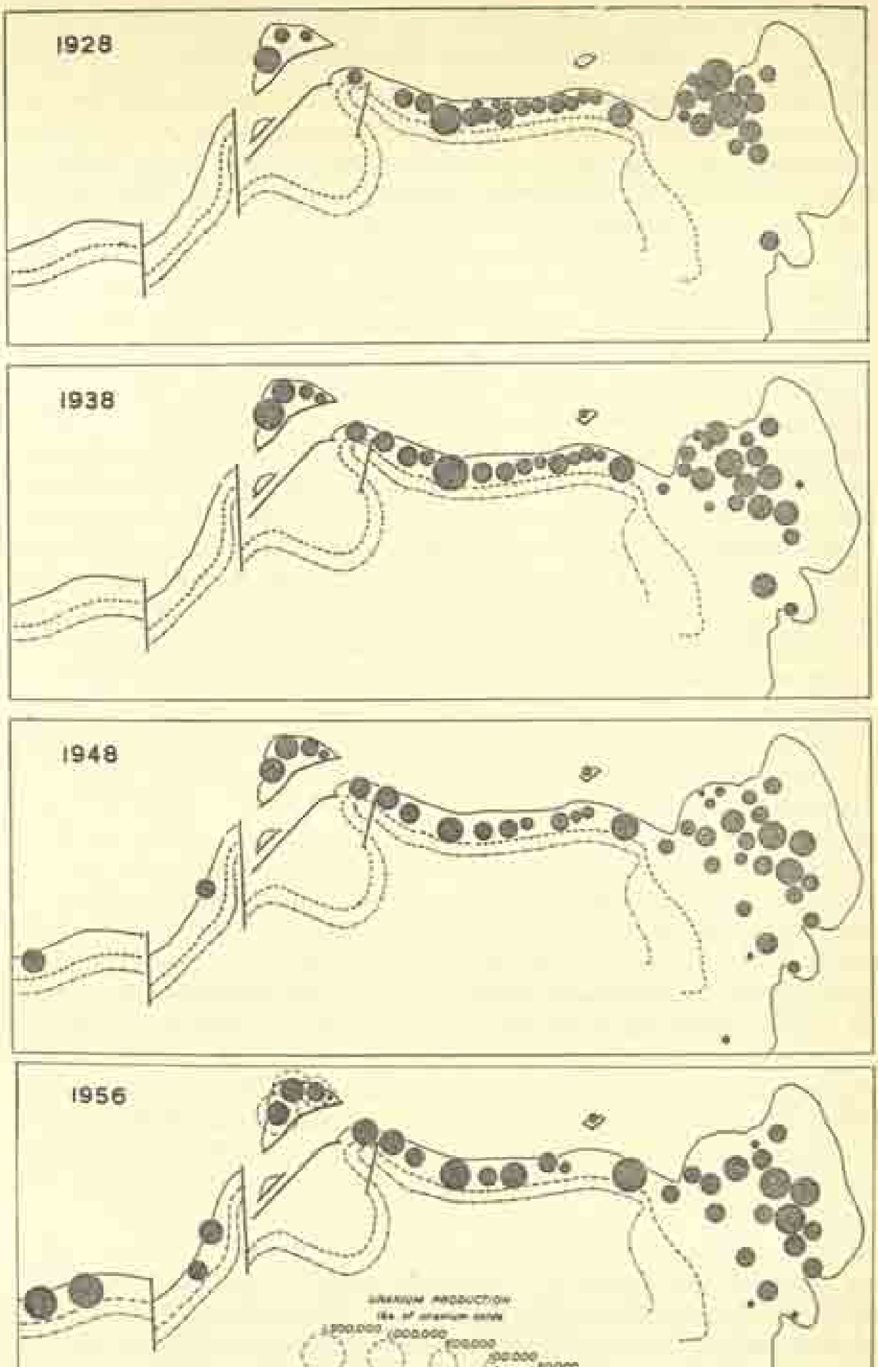
The period from 1912 to 1923 was one of labour difficulties and fluctuating production during which the output from the Central Rand steadily declined while that from the Far East Rand steadily increased (see Fig. 111), finally exceeding that of the Central Rand in 1924. On the Central Rand many of the outcrop mines and some of the deeper ones closed down because of the exhaustion of payable ore. Altogether nineteen mines ceased operations and not a single one began producing. On the Far East Rand, however, the discovery of rich 'pay-streaks' and the introduction, in 1916, of the Francois cementation process, whereby shafts could be sealed from water-bearing fissures, stimulated development. Here six new mines were opened. Despite the progress made on the Far East Rand, however, the total gold production in 1922 was slightly less than that of 1912. For this an acute shortage of labour occasioned by the first world war and the unrest which followed it was largely responsible. Despite the efforts of the Native Recruiting Corporation, formed in 1912 to draw Native workers from the Union and the Protectorates, the number availing themselves dwindled. And in 1913 recruitment north of latitude 22° S., was prohibited because of the high death-rate from pneumonia among the Tropical Natives. The consequent labour shortage caused the first decrease in the annual output of gold since the South African War. Eventually the position was eased only by closing the low-grade mines and increasing mechanization on the more profitable ones. By 1923 the number of producing mines had fallen to 40.

Meanwhile measures were taken to augment the water supply by the construction of a barrage on the Vaal river, 25 miles below Vereeniging (ch. 7, p. 150) completed in 1923, while following the decision to open a branch of the Royal Mint at Pretoria, the Rand Refinery was established at Germiston in 1921.

After 1924 the Far East Rand assumed a dominant position as production from the whole field increased steadily to reach a maximum of nearly 14½ million fine ounces in 1941. The gold industry was unaffected by the onset of the world depression in 1929 and the output continued to increase until 1932 when abandonment of the gold standard resulting in an increased price for gold permitted the mining of lower-grade ore, thereby causing a fall in the average yield and in total production. The higher gold price, however, brought some of the lesser reefs within the range of payability; the development of new mines on the Far East



Figs. 108–11. The Witwatersrand goldfield; gold production, 1888–1918.
(After P. Scott, courtesy of the *Geographical Review.*)



Figs. 112–15. The Witwatersrand goldfield; gold production 1928–56, uranium production, 1956.

(Figs. 112–14 after P. Scott, courtesy of the *Geographical Review*.) Note that on the Far West Rand, the Doornfontein mine, which had an output of 321,071 fine ounces of gold and 15,803 lb. of uranium oxide in 1956, is not shown; the mine is just west of the Blyvooruitzicht mine, the most westerly one shown on the map.

Rand was accelerated and the decline of the Central Rand was arrested. The number of producing mines, which had fallen to 32 in 1930, increased to 40 by 1938; none ceased operations on the Central Rand while eight new ones began producing on the Far East Rand. Steady expansion took place on the West Rand. In consequence of these developments the total output increased steadily after 1934 although the yield of gold per ton of ore milled fell sharply. On the Central Rand it averaged 4·4 dwt. at the mines working the principal reefs but only 3·7 dwt. at those working the lesser reefs. On the Far East Rand the figures were respectively 5·8 and 3·4 dwt.

Labour difficulties continued until the World Depression, becoming acute after 1928 when the Mozambique Convention set a limit on the number of Portuguese Natives that might be employed and reduced their period of service. Low agricultural prices during the depression years, however, forced many Natives into employment (see Fig. 116) while after 1936 successful inoculation against pneumonia made possible the resumption of recruitment of Tropical Natives in areas north of latitude 22° S. In the same year the coming into operation of the new Klip river power station (ch. 23, p. 388) promised to meet the increasing electricity requirements of the mines and two years later the completion of Vaaldam (ch. 7, p. 134) promised to satisfy the increasing demand for water.

After 1941 the gold industry suffered increasingly from shortages of essential materials, of labour, and of capital consequent upon war-time conditions; developing mines had to be closed while on the older mines the rising costs of production made the lesser reefs unpayable. Production fell sharply until 1949* (see Fig. 100) when the increase in the sterling price of gold following devaluation of the £ sterling again made much of the low-grade ore payable. The number of producing mines increased to 45. The tonnage of ore milled increased steadily but until 1952 there was no appreciable increase in the gold output. Throughout the period the Far East Rand remained as the dominant producer despite a steady fall in output from a maximum of 7,273,615 fine ounces in 1941 to 4,820,381 fine ounces in 1952. On the Central Rand production rose to 4,900,126 fine ounces in 1941, the highest output since 1917, but thereafter fell as smaller tonnages were mined and the yield of gold per ton of ore milled declined. By contrast the relative importance of the West Rand increased while the Far West Rand emerged as an important producer actually overtaking the West Rand in 1951. Production began on the Far West Rand in 1939 when Venterspost began crushing ore from the Main and Contact Reefs. Three years later Blyvooruitzicht began milling ore from the Carbon Leader. This horizon has proved to be 100 per cent payable and to have an exceptionally high gold content. The yield reached a maximum of 16·68 dwt. per ton milled in 1947 and while it fell to 12·22 dwt. in 1952 it is well above the average for the Rand. Moreover, the West Driefontein mine,

* The lowest output actually occurred in 1947 when six to seven weeks were lost as a result of a strike.

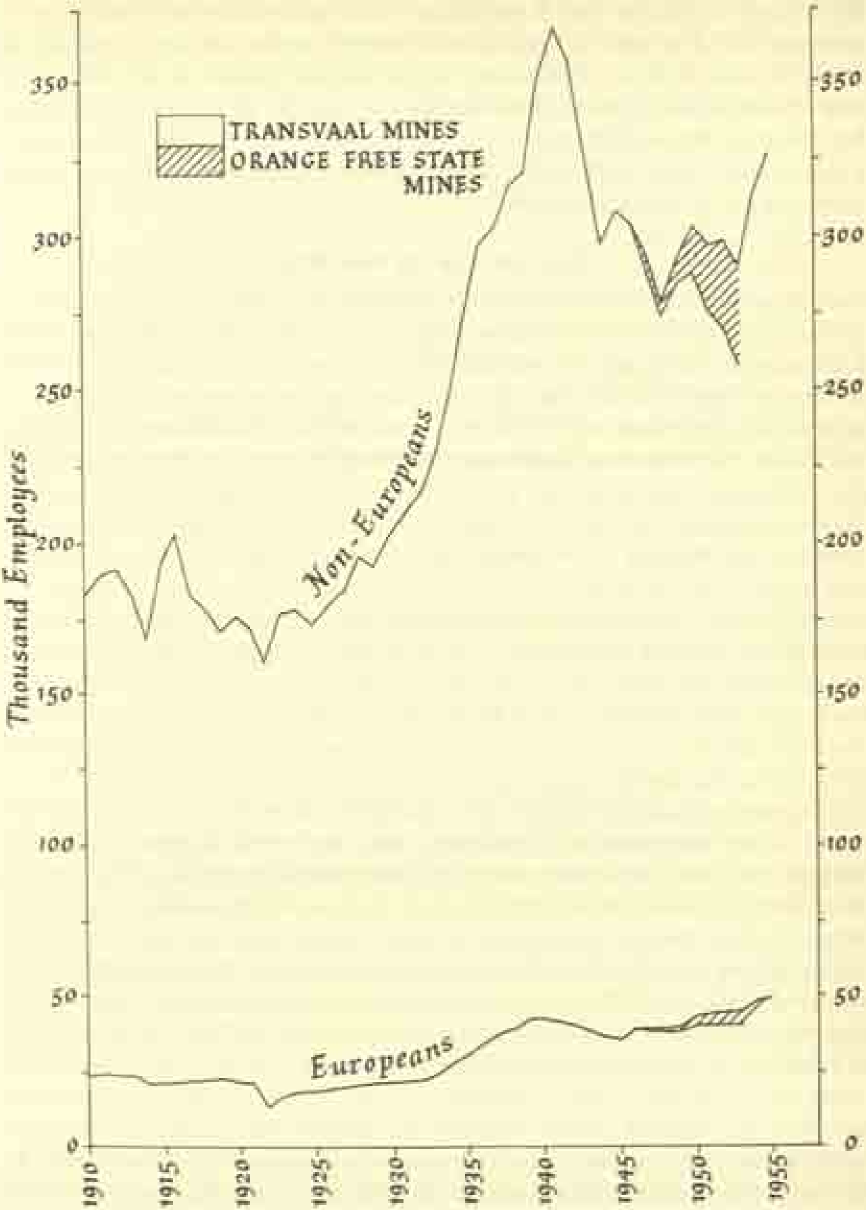


Fig. 116. Number of employees in the Transvaal and Orange Free State gold mines, 1910–55.

Separate figures for the Transvaal and Orange Free State are not given for 1954 and 1955.

working the same reef, began producing in 1952 with an average yield of 10·93 dwt. By contrast the yield at the Libanon mine, working the Main and Contact Reefs, averaged only 3·23 dwt. in 1949, its first year of production, and 3·74 dwt. in 1952. With development proceeding on the Carbon Leader at two other deep level mines to the south of West Driefontein the Far West Rand promises to become an increasingly important producing region. In 1955, the five producing mines yielded over 2 million fine ounces of gold representing 24 per cent of the output of the Witwatersrand field.

The Klerksdorp Goldfield

Auriferous reefs were found west of Klerksdorp in 1887 and in the following years a large number of small companies began mining operations.[16] Because of the isolation of the area and low payability of the reefs, however, many of the enterprises were short-lived and until the 1930's little interest was shown in the region. At that time there were only a few small mines working the Government Reef of the Lower Witwatersrand Series and the Black Reef of the Transvaal System near their outcrops around the periphery of a shallow basin. The Upper Witwatersrand Series, covered by younger rocks, had not been discovered. In 1933, however, the Western Reefs Exploration Company began a thorough geological and geophysical survey of the area south and east of Klerksdorp, which proved the existence of Upper Witwatersrand sediments and resulted in the establishment of the Western Reefs Mine in 1938. At first the Ventersdorp Contact Reef and several reefs in the Elsburg quartzites were exploited but in 1942 boreholes were sunk to a deeper level and the horizon now known as the 'Vaal Reef' encountered for the first time. This has since been proved over a wide area and has led to the development of new mines.

At present mining is carried on in two distinct areas, one to the west and the other to the south-east of Klerksdorp (Fig. 117). The former is relatively unimportant; two small mines work the Government Reefs but a third which worked the Dominion Reefs at the foot of the Lower Witwatersrand Series was forced to close down in 1952, owing to rising costs and the low grade of the ore which latterly yielded only 2 dwts. per ton of ore milled. Most important is the new area south-east of Klerksdorp where there are now nine mines, four of them post-war, and four others likely to be developed.[17] Here, the Upper Witwatersrand sediments with the Vaal Reef near their base appear to have been preserved in a down faulted trough. At the Stilfontein mine the Vaal Reef has been intersected at depths of 2,400 and 3,600 feet while at the Ellaton Mine it has been located at only 300 and 770 feet, both mines being near the western limit of the trough. In contrast it has been identified at a depth of 5,882 feet on Vaal Reefs and at a depth of 6,233 feet on Western Reefs. While its depth is thus very variable it maintains a high percentage of payability and promises a gold yield exceeding that of the Orange Free State Mines. The Stilfontein mine came into production in 1952, only three years after the commencement of diamond drilling, while four others

are expected to follow shortly. It is estimated that the possible mines will not be in production before 1965 and on the assumption that their life will be at least 35 years, it is anticipated that gold will be produced from the Klerksdorp area

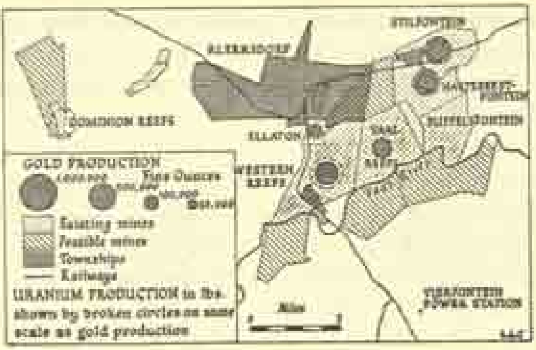


Fig. 117. The Klerksdorp goldfield; mining areas, gold and uranium production in 1956.

(Mining areas after the Natural Resources Development Council, gold and uranium production from the 67th Annual Report of the Transvaal and Orange Free State Chamber of Mines.)

after the turn of the century by which time most of the Rand mines will have ceased operations. The rapid and promising developments in the post-war years led to the proclamation of the goldfield on a controlled area coming under the wing of the Natural Resources Development Council in 1952, thereby ensuring its proper planning.[17, 18]

The Orange Free State Goldfield

In contrast to the Witwatersrand and Klerksdorp fields, this goldfield is wholly concealed, the Upper Witwatersrand sediments occurring beneath a cover of from 300 to 4,000 feet of Ventersdorp and Karoo rocks. Hence its late development. Drilling actually began in the early 1930's but it was not until 1938 that payable reef was struck north of Odendaalsrus. The war then intervened and it was not until after 1945 that development went ahead. At this stage the area was brought under the planning control of the then newly established Natural Resources Development Council in order to ensure the orderly and parallel development of mines, townships, and communications.

The Upper Witwatersrand sediments occupy a shallow wedge-shaped depression probably downfaulted. Despite intensive geophysical prospecting and drilling no gold-bearing areas have been discovered beyond its limits, while within it there are two block-faulted areas in which the reefs are below the maximum depths of economic mining.[19] The most important gold-bearing horizon is the Basal Reef; owing to faulting the depth at which this occurs varies greatly, ranging from 750 to 6,100 feet, but generally less than 4,500 feet. In the

west the reef dips eastward at about 20° near Allanridge, 10° near Odenaalsrus, and 26° near Welkom, while near Virginia it has a westward dip of about 10°. The payable ore occurs in lenses which promise to yield about 7 dwts. of gold per ton, nearly double the average for the Rand in 1950. In addition to the Basal Reef, the higher horizon of the Leader Reef, which is consistent but narrower and less valuable, the B Reef, the A Reef, the Upper Reefs, and the Ventersdorp Contact Reef[20, 21] are expected to yield gold on some mines.

Fig. 118. The Orange Free State goldfield; mining areas, gold and uranium production in 1956.

(Mining areas after the Natural Resources Development Council, gold and uranium production from the 67th Annual Report of the Transvaal and Orange Free State Chamber of Mines.)

The existing mines are mostly on the western flank of the depression (see Fig. 118) where a new mine will probably be established between Freddies North and Loraine to work the Basal Reef which borehole records indicate has an exceptionally high gold content in this area. Two new mines are likely west of Whites and also west of the Harmony mine, while two small mines, one working the A Reef, which has proved payable at shallow depths south-east of Hennenman, and the other working the Leader Reef east of Virginia, are possible in the east.

While the reefs occur mainly at depths appreciably less than those now

worked on the Rand, the field suffers to a greater extent from faulting, with vertical displacements ranging from a few feet up to 1,800 feet, and has a steeper geothermic gradient, which causes the temperatures at 5,000 feet below the surface to be as high as those at 8,500 feet on the Rand.[22] Consequently below 4,500 feet it is desirable and below 5,000 feet essential to refrigerate the ventilating air.[23] At present humidity control is difficult owing to the presence of large quantities of ground water seeping into the workings from water-bearing fissures beneath the Ventersdorp lavas, and necessitating the cementation of both shafts and underground workings. As this water is pumped to the surface it is anticipated that in time a drier atmosphere underground will result.

The location of the goldfield in a hitherto remote part of the Highveld has necessitated the provision of essential services and improvements in communications. Water has been a major problem. Except for the Sand river, a tributary of the Vaal, the only surface water is found in salt pans occupying shallow surface depressions. Mine water, which supplies half the needs of the Rand gold mines, cannot be used in the reduction plants owing to its high salinity. Hence all the water supplies have had to be brought from outside. To do this a pumping station has been built on the Vaal at Balkfontein whence water is lifted 1,000 feet in 44 miles to reservoirs at Kopje Allen, the only hill in the area, from which it is distributed by gravity to the mines and townships of the region.[24] In order to meet the electricity supplies of the area a new power station is being built at Vierfontein (ch. 23, p. 390) 55 miles north of Odendaalsrus. The old settlements of Odendaalsrus, Hennenman, and Virginia are expanding into towns, the new townships of Welkom, Allanridge, and Van Riebeeckstad growing while further new ones are planned at Blaauwdrift and West Virginia.[25, 26] A branch railway has been built from the main Johannesburg-Bloemfontein line to Odendaalsrus whence it is to be extended northwards to Allanridge and perhaps at a later date to the Bultfontein–Bothaville line, thereby affording a second connection with the Rand. Tarred highways are being constructed to Odenaalsrus, Kroonstad, and Klerksdorp respectively in order to provide first-class road links with the Rand.[27]

Thus the stage is set for expanding production. At present there are 13 mines of which two – St Helena and Welkom – began producing in 1952, five others in 1953, and three others in 1954. In 1955 with a gold output of 2,314,531 fine ounces the total production from the field exceeded that of the Far West Rand. All the mines should be in production by 1957 while it is expected that the number of mines will exceed 20 by 1966. The mining properties resemble those of the Far East Rand in being delimited by sub-outcrops or other mines in consequence of which their productive lives cannot be prolonged by progressively deeper mining as on the Central Rand or in future on the Far West Rand. But the average claim area is larger and with a milling rate of 100,000 tons of ore per month most mines should remain in production for at least 30 years and given a high percentage payability and more than one payable reef perhaps for 50 years or more. Here the high yield of gold – reaching 11·86 dwts. per ton in November 1954 – obtained

at the President Brand mine, originally classified as one of the lower grade mines, is noteworthy. The goldfield is expected to reach its maximum production by 1970 and should not begin to decline until 1990.[28] Thus the industry forming the economic backbone of the country seems assured for a sufficiently long period to enable the full development of manufacturing industries.

The Eastern Transvaal Goldfield

Interest in the gold mining potential of the eastern Highveld began about 1935 when considerable drilling activity took place between Leslie and Bethal. The results, however, were all negative and the options held at that time were abandoned. In 1949 interest was re-awakened and in 1954, following intensive borehole drilling, gold in payable quantities was found in the Kimberley Reef between and south of Kinross and Trichardt.[29] Acting on the information supplied by the company concerned, that some mining development was bound to commence, shortly afterwards an area of 1,100 square miles was brought under the control of the Natural Resources Development Council in order to provide for the proper planning of the new goldfield. The new goldfield is a concealed one, the Witwatersrand rocks being overlain by rocks of the Karoo system, including coal seams which will probably be worked to supply the demand for power, steam and heat. As yet little is known of the goldfield beyond the location of the gold reef sub-outcrop.

Mining Methods

The Witwatersrand gold mines are unique in their great depth. Mining at such depths is extremely costly and is possible only by virtue of favourable geological conditions, notably a strong hanging wall to the reefs, highly mechanized methods, and the great value of gold. Today intensive geophysical prospecting and drilling precede shaft sinking. The shafts are vertical and from them levels are driven to the reefs, which are worked by overhead or back stoping, whereby the ground is worked out in the shape of a section of a cone. In the early days pillars of rock were left intact as the main support; today 'cribs' or 'pigsties' filled with rock are most usual but stone packs, concrete monoliths and pancakes, and timber mat packs are also used. Support on a large scale is also obtained by filling the excavation with sand from the reduction plant. With increasing depth stronger supports become necessary, stone being preferred to timber. The danger of rock bursts consequent on increasing pressure is less of a limitation to deep level mining, however, than high temperatures and dust.[30, 31] The geothermic gradient is 1° F. for every 185 feet in depth on the Central Rand, for every 125 feet on the Far West Rand, and for every 109 feet in the Orange Free State. At a depth of 9,000 feet on the Crown Mines, Johannesburg, the rock temperature is 109° F. To allay dust conducive to miners' phthisis and silicosis wet mining methods are employed and the consequent saturation of the air combined with the high temperatures produces very trying conditions necessitating the refrigeration of

the ventilating air. Dry mining methods which would mitigate the problem and permit mining to proceed to 12,000 feet are being investigated but ultimately the expense involved will place a limit on the depth worked.

Deep mining has been possible only with cheap labour and highly mechanized methods. The industry has always been faced with a shortage of both skilled European and unskilled Native labour. This is more than ever true today when the developing secondary industries of the country offer attractive alternative employment. Since 1945 efforts to recruit European miners from Europe have met with some success. The activities of the Witwatersrand Native Labour Association have been extended in Bechuanaland, Barotseland, and Nyasaland, and in 1952 in order to facilitate the transport of Natives from these territories special air services from Lilongwe in Nyasaland and Mohembo in northern Bechuanaland to Francistown, the entrainment centre for Johannesburg, were started. Hostel accommodation is provided for the majority of Native workers, most of whom are migrant labourers; in addition on the Free State mines detached or semi-detached houses have been built in model villages for married employees bringing their families[22] and it is hoped in this way to obtain the nucleus of a stable labour force. The number of Natives coming forward, however, falls short of the requirements and further mechanization is vital. Since the war such progress has been made in this direction that by 1951, 88 Natives could handle the same tonnage of ore as 100 Natives in 1945. Today electric drills are in common use, the ore is moved underground in trucks either drawn by electric locomotives or operated on endless rope haulage systems and is hoisted through the shafts by electric winding engines. But if the industry is to maintain its output further labour economies will have to be effected.

Ore Treatment and Uranium Extraction

The processes in the reduction of the ore are shown diagrammatically in Fig. 191. The bullion produced is then sent to the Rand Refinery, at Germiston, while the enormous quantities of sand and slime are tipped to form the huge mine dumps which characterize the Rand and create a major planning problem. Since 1949, however, the slimes have become an important source of uranium[23] at a number of mines. The presence of radio-active minerals in the gold-bearing ores of the Witwatersrand Series had been known for over forty years. In 1923 this radioactivity was shown to be due to uraninite (an impure oxide of uranium) which was present in such small quantities that it could not possibly compete with the pitchblende deposits of the Belgian Congo, Canada, and Bohemia. In 1944, however, the United States Government became interested in the possibility of uranium extraction from the Witwatersrand ores. Intensive investigations followed and, after the formation of the South African Atomic Energy Board, the first pilot plant for the extraction of uranium was installed at the Blyvooruitzicht gold mine (on the Far West Rand) in 1949 and the second at the Western Reefs Exploration and Development Co. mine (on the Klerksdorp goldfield) in 1950.

By the end of 1955 seventeen plants were in production, six in the Orange Free State and five on the West Rand. With the fulfilment of present plans uranium will be extracted from the ores of 26 gold mines, many of which, however, will feed their residues to a central treatment plant. In 1956 over 8 million lb. of uranium oxide were produced and exports were valued at £39 million. In 1955

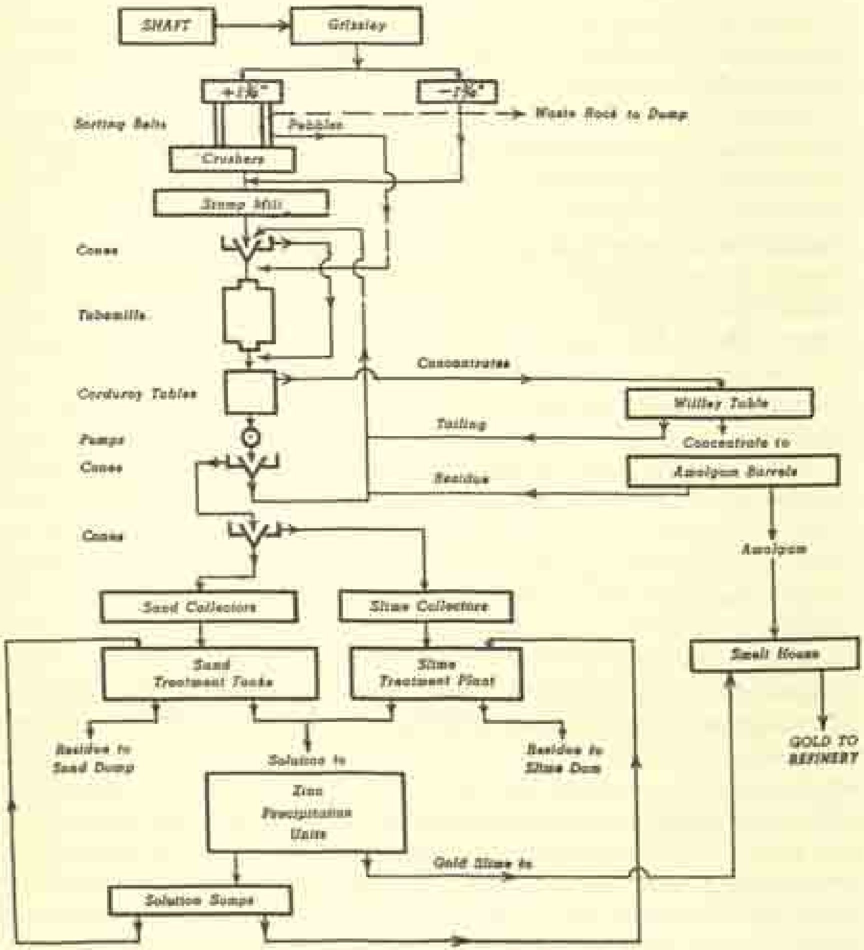


Fig. 119. Flow sheet of typical reduction plant on a Rand gold mine.

the working profits derived from uranium extraction exceeded those derived from gold extraction on the seventeen producing mines taken together and on five of them they actually offset working losses incurred in the production of gold. Uranium extraction is indeed prolonging the life of several of the Witwatersrand gold mines and with the accumulated slimes of the past sixty years as

well as the current slimes available for treatment, the world's greatest goldfield promises to become the world's greatest uranium field as well. Indeed already South Africa is the world's leading producer of inert uranium oxide which is exported to the U.S.A. and the U.K.

Platinum

Following the discovery of the Witwatersrand goldfield hopes of finding platinum deposits were entertained from time to time but it was not until 1924 that the important reserves of the Bushveld Igneous Complex were located.[39]

Here platinum occurs both in metallic form in dunite pipes and as platiniferous sulphides in the sheet known as the Merensky Reef within the norite. The latter is the more important. It conforms to the general pseudostratification of the complex dipping gently inwards at angles of between 10° and 15° towards the centre of the Bushveld basin and outcropping around the rim; here it has been located at intervals, over a distance of 100 miles in the Lydenburg and Pietersburg districts, over 180 miles in the Brits and Rustenburg districts and over some 40 miles in the Potgietersrust district. Mining is relatively easy by incline or vertical shafts to shallow depths. The platinoid content of the ore however is low averaging only 2 dwts. per ton in the eastern belt and between 5 and 7 dwts. per ton near Rustenburg.

Platinum production has been influenced primarily by world demands which in turn have depended on the discovery of new uses for the metal which is infusible, malleable, and ductile and harder than gold. In 1924 the jewellery trade was the main consumer and the demand small. At first production was confined to the dunite pipes near Lydenburg. Hitherto platinum had been produced in other countries either from alluvial deposits or as a metallurgical by-product from other mineral ores. Difficulties were experienced in extracting the platinum from the complex sulphides[40] of the Merensky Reef and it was not until 1927 that a satisfactory treatment process was discovered. The richer and more accessible Rustenburg section was then opened and production increased rapidly to reach 55,000 fine ounces in 1930, when as a result of the increased output from all producers, the limited world consumption, and the onset of the general trade depression, the price fell from £30 to £7 per fine ounce. This led to a general closing down of platinum mines and as a result of elimination and absorption among the various companies, only one – Rustenburg Platinum Mines – remained at the end of 1932. At the same time the leading producing countries – Russia, Canada, South Africa, and Colombia – agreed to restrict their sales on a quota basis.[41] This served to stabilize the price but also to limit output. In the late 1930's, however, new uses for the metal, in the electrical industry, in the manufacture of precision instruments, as a catalyst in the chemical industry, in crucibles and laboratory ware, in aeroplane engines during a period of rearmament, led to increased demands and by 1938 the South African output approached the 1930 level. The war brought new uses and new demands and particularly

with the development of atomic energy these have increased in the post-war era. South Africa, probably possessing the largest reserves in the world, has increased her production fourfold since 1948 (Fig. 120) and in 1953 when her output

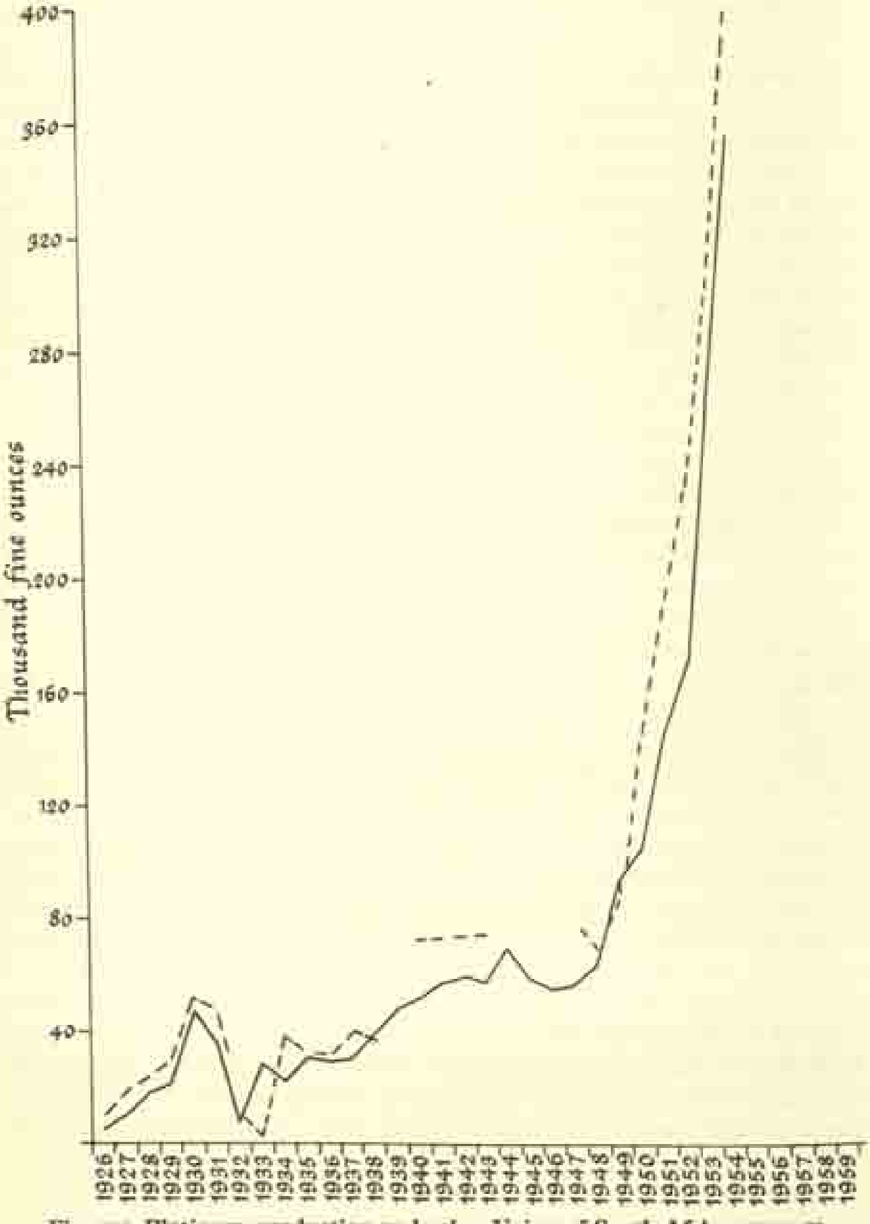


Fig. 120. Platinum production and sales, Union of South Africa, 1910–53.

reached almost 300,000 fine ounces she became the world's leading producer, overtaking Canada, hitherto the most important. Parallel with the expanding output changes have occurred within the industry. After 1932 activities were concentrated near Rustenburg where the ore was reduced by means of gravity concentration followed by flotation in a plant capable of treating 10,000 tons per month. The concentrate was then sent to England for further treatment. With increasing output the capacity of the plant was doubled in 1937 and a blast furnace and converter added and the enriched matte containing nickel and copper along with the crude platinoids obtained by gravity concentration sent overseas. Further extensions were effected during and after the war both at Rustenburg where the present milling capacity is 75,000 tons per month, and at new mines west of Northam where the milling capacity is 27,000 tons per month.[12] Finally in 1953 when platinum fetched £33·5 per fine ounce on the open market and £55 on the black market work began on the erection of a refinery in Rustenburg.[13] At present only the richer sections of the Merensky Reef adjacent to existing railways are worked and there remain large reserves of easily mined ore for the future.

BIBLIOGRAPHY

Gold and Uranium

1. *The Mineral Resources of South Africa.* Union of S.A. Geol. Surv. Pretoria. 1940.
2. SEE C. BICCARD JEPPE. *Goldmining on the Witwatersrand.*
3. B. B. BROCK. 'The Vredefort Ring'. *T.G.S.S.A.*, Vol. LIII, 1950, pp. 131–59.
4. B. B. BROCK. 'The Vredefort Ring. *S.A. Min. (Eng.) J.*, Oct. 1950.
5. E. T. MELLOR. 'The Upper Witwatersrand System'. *T.G.S.S.A.*, Vol. XVIII, 1915, pp. 11–56.
6. See E. T. MELLOR. *Geological Map of the Witwatersrand Gold Field.* 3 sheets. 1:60,000. Union of S.A. Geol. Surv. Pretoria. 1917. This map shows the outcrop of the principal reef groups.
7. LEOPOLD REINECKE. 'The location of payable ore bodies in the gold-bearing reefs of the Witwatersrand'. *T.G.S.S.A.*, Vol. XXX, 1927, pp. 89–119.
8. E. T. MELLOR. 'The East Rand'. *T.G.S.S.A.*, Vol. XVIII, 1915, pp. 57–71.
9. E. T. MELLOR. 'Structural features of the western Witwatersrand'. *T.G.S.S.A.*, Vol. XVI, 1913, pp. 1–32.
10. R. A. PELLETIER. 'Contributions to the geology of the Far West Rand'. *T.G.S.S.A.*, Vol. XL, 1937, pp. 127–62.
11. PETER SCOTT. 'The Witwatersrand goldfield'. *G.R.*, Vol. XLI, No. 4, 1951, pp. 561–89. From which much information is taken.
12. G. A. WATERMEYER and S. N. HOFFENBERG. *Witwatersrand Mining Practice.* Johannesburg. 1932.
13. *The Mining Industry. Evidence and Report of the Industrial Commission of Enquiry.* Johannesburg. 1897.

14. See J. H. CURLE. *The Gold Mines of the World*. London. 1899.
15. R. STOKES, J. E. THOMAS and others. *Rand Metallurgical Practice*, Vol. I, London, 1912, p. 12.
16. JACK SCOTT. 'The Klerksdorp Goldfield'. *S.A.J. Econ.*, Vol. XXI, No. 2, 1953, pp. 118–30.
17. 'The Klerksdorp goldmining region'. 5th annual report of Natural Resources Development Council for the year 1952. *Supplement to Commerce and Industry*. Vol. XII, No. 10, 1953.
18. See Potchefstroom University, 'Survey of the Klerksdorp goldmining area'. *Supplement to Commerce and Industry*, Vol. XIII, No. 2 1954, pp. 92–116.
19. PETER SCOTT. 'The Orange Free State Goldfield'. *Geog.*, Vol. XXXIX, pt. I, No. 183, 1954, pp. 13–20.
20. See VIVIAN BAINES. 'The geology of the Odenaalsrus Goldfield'. *T.G.S.S.A.*, Vol. LII, 1949, pp. 301–30.
21. See VIVIAN BAINES. 'The Free State Goldfield. Geological relationship to the Klerksdorp area'. *S.A. Min. (Eng.) J.*, Vol. LXI, 1950.
22. R. BORCHERS and G. V. WHITE. 'Preliminary contribution to the geology of the Odendaalsrus goldfield'. *T.G.S.S.A.*, Vol. XLVI, 1943, pp. 127–53.
23. C. BICCARD JEPPE. 'Shaftsinking and development in the Orange Free State Goldfields'. *Optima*, Vol. I, No. 2, 1951, pp. 8–19.
24. 'Water Supplies to the O.F.S. Goldfield'. *S.A. Min. (Eng.) J.*, Vol. LX, pt. 2, 1949–50, p. 151.
25. Third Annual Report of the Natural Resources Development Council. *Supp. to Commerce and Industry*, Vol. IX, No. 10, 1951, pp. 475–91.
26. Sixth Annual Report of the Natural Resources Development Council. *Supp. to Commerce and Industry*, Vol. XII, No. 10, 1954, pp. 497–508.
27. The Natural Resources Development Council. *A Regional Survey of the Orange Free State Goldfield*. Pretoria. 1954.
28. Union of S.A. Social and Economic Planning Council. Rep. No. 11. *Economic Aspects of the Gold Mining Industry*. Pretoria, 1948, pp. 16–17.
29. F. W. QUASS and J. B. WILLERS. Natural Resources Development Council, 'Survey of Controlled Area No. 3. (The New Eastern Transvaal Goldfields)'. *Supp. to Commerce and Industry*, Vol. XV, No. 12, 1956.
30. Report of the Committee on Deep Level Mining. Pretoria. 1945.
31. A. J. WALTON. 'Some problems of deep mining'. *J. S. Afr. Inst. Eng.*, Vol. XLIII, 1944–5, pp. 127–42.
32. H. OPPENHEIMER. 'The Orange Free State Gold Fields'. *S.A. J. Econ.*, Vol. XVIII, 1950, pp. 148–56.
33. See D. L. NIDDRIE. 'Uranium from the Union of South Africa'. *Geog.*, Vol. XL, pt. 3, 1955, pp. 193–4.
34. Annual Reports of the Transvaal (and latterly also Orange Free State) Chamber of Mines. Contain statistics of output, working costs, etc., for all the member mines.

35. Annual Reports of the Witwatersrand Native Labour Association.
36. The South African Mining Yearbooks. Contain detailed information of developments, etc., at individual mines, company reports, etc.

Platinum

37. P. A. WAGNER. *The Platinum Deposits and Mines of South Africa.* Oliver and Boyd. Edinburgh. 1929.
38. P. A. WAGNER. *Preliminary Report on the Platinum Deposits in the South-eastern part of the Rustenburg district, Transvaal.* Geol. Surv. Mem., No. 24. Pretoria. 1926.
39. *The Mineral Resources of the Union of South Africa.* Union Dept of Mines. Pretoria, 1940, pp. 186–93.
40. J. E. HEALEY and T. K. PRENTICE. 'The Mining and Recovery of Platinum at Onverwacht'. *Emp. Min. Metall. Cong.* 1930.
41. E. F. JEAL. 'The Platinum Group Metals'. *S.A. Min. Eng. J.*, Vol. LXIII, pt. 1, 1952, p. 1081.
42. *S.A. Min. Y.B.*, 1950–1.
43. *Commerce and Industry.* July 1953.

20

Base Metals

The base metals fall into three categories – (*a*) those essential to the production of iron and steel and including iron (see ch. 25) and manganese, (*b*) those used for alloying with pig iron in the manufacture of special steels – manganese, chromium, nickel, tungsten, vanadium, cobalt, and molybdenum, and (*c*) those used for special purposes outside the iron and steel industry – copper, tin, lead, antimony, etc. South Africa mines most of these metals for export, consequently their production has been greatly influenced by world market conditions. In the case of some of them the U.S.S.R. is an important producer. The South African production of most base metals fell during the depression of the early 1930's and that of manganese and chrome, especially after the U.S.S.R. dumped large quantities at low prices on world markets. The production of some rose sharply during the second world war and during the subsequent period of stockpiling. Today world politics greatly influence the production of strategic minerals. The U.S.S.R. no longer supplies the Western World but the lessening of international tension and a resumption of free trade between East and West would alter the position. South Africa might then have difficulty in competing with Soviet Russia in the production of some of the minerals with which she is well endowed.

Manganese

After iron ore, coke and limestone, manganese is the most important raw material of the modern iron and steel industry, in which it plays a triple role. The ore is used in the blast furnaces producing pig iron for basic steel manufacture, 1 cwt. per ton of pig iron being added mainly to neutralize the harmful effect of sulphur. Ferro-manganese is employed as a deoxidizer in steel melting while small quantities of the metal are used in the production of high manganese steel which is exceptionally tough and resistant to wear. The demand for manganese is closely related to activity in the world's heavy industries and since 1939 has been conditioned by strategic considerations.

South Africa possesses large reserves of manganese ore closely associated with iron ore in Griqualand West.[1] The deposits were first discovered near

Postmasburg in 1922 and have been worked since 1929. Since 1940 further deposits have been located in South West Africa where production commenced in 1950.

The Postmasburg manganese ores occur in two belts – a western one extending along the Gamagara ridge for some 34 miles and an eastern one comprising a line of detached hills and ridges rising from a level dolomite plain. In both areas the ore is found near the contact of the dolomite and the overlying formations (Fig. 121) but its mode of occurrence differs. In the eastern belt it is confined to irregularly distributed tabular or funnel-shaped ore bodies. In the central part of the Gamagara ridge it occurs as a bedded deposit, with in places massive bodies of higher grade ore produced by secondary enrichment; thick detrital ore deposits occur on the eastern side of the ridge. Farther west deposits occur on the

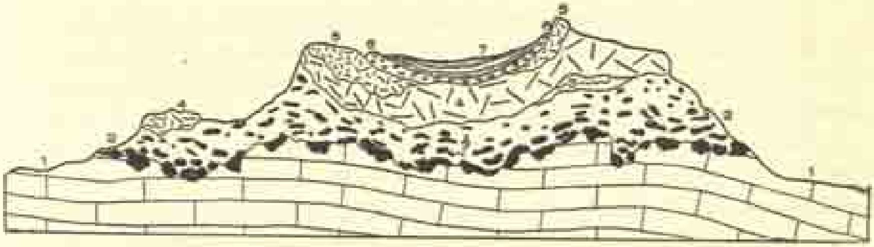


Fig. 121. Section across the Gamagara ridge near Postmasburg, showing the iron ore and manganese deposits.

(After the Geological Survey, courtesy of the Government Printer, Pretoria.)

1. Campbell rand dolomite. 2. Siliceous breccia and gouge with pockets of manganese ore. 3. Contorted and partly silicified Gamagara shale. 4. Brecciated banded iron-stones (Blinkklip breccia). 5. Ferruginized breccia constituting iron ore. 6. Ferruginized shale and basal conglomerate of the Gamagara series, largely constituting iron ore. 7. Shales and thin quartzites of the Gamagara series.

limbs of a north/south trending anticlinorium on Aucampsrust where, due to lower elevation, the manganese-bearing strata has been less eroded than on the Gamagara rand.

In both belts the ores are hard, do not crumble in handling or transit and do not disintegrate after prolonged storage. Consequently they are much in demand on world markets. They contain very little phosphorus, 0·02 to 0·15 per cent – or other impurities. The manganese content, however, varies greatly. The ores represent metasomatic replacement deposits formed at the same time as the iron ores (ch. 25, p. 412), the heavier metal, i.e. manganese, occupying the lower horizons. Thus the manganese ore bodies lie below the haematite iron ores but between the two the rocks grade from ferruginous manganese to manganiferous iron deposits. The total content of manganese plus iron is remarkably consistent at 56 to 60 per cent but whereas the lower ore bodies contain upwards of 50 per cent manganese the amount decreases to 30 per cent in the upper beds where the

iron content is as much as 32 per cent. The grade worked depends on market conditions and the ease and cost of mining. Generally speaking the higher grade ores occur in the eastern belt where, however, the sporadic nature of the deposits increases the cost of mining. In the western belt much of the ore contains only about 45 per cent manganese but the large reserves and the fact that working faces exceeding 30 feet in solid ore are common makes for cheap mining. The detrital deposits are very easily won, using picks and shovels; in the west they may be worked to a depth of 10 to 15 feet and yield up to 80 per cent ore of low grade.

The exploitation of the manganese deposits has been governed by two main considerations, the overseas demand for the ore and the ability of the railways to move large tonnages over the 600 miles of country to the port of Durban for export.

Mining began in the western belt in 1929 and at the same time the Kimberley–Koopmansfontein railway was extended to Postmasburg and Beeshoek, thereby linking the ore field with Durban. A crushing and sorting plant was erected at Beeshoek and storage bins and a loading plant at Durban. The output reached 162,394 tons in 1930 but the subsequent fall in world prices brought operations to a standstill in 1932. Markets then improved and in order to facilitate development all the deposits in the western belt, except those at Lohathla, were brought under the control of one concern, the Associated Manganese Mines of South Africa Ltd. in 1935; at the same time the railway was extended to Lohathla and a branch line constructed to Manganore in the eastern belt. Strong German buying for stock-piling in preparation for war stimulated production (Fig. 122) and by 1937, with an output of 621,229 tons, the Union became the world's third largest producer. To meet the war needs of the Allies, particularly after the destruction of the Nikopol mines of the Ukraine by the German armies, strenuous efforts were made to increase production. Transport and labour difficulties, however, restricted operations and in 1945 the output fell to only 126,265 tons. After the war the heavy demand, particularly from the U.S.A., continued but inability to move large tonnages of ore over her over-burdened railway system prevented South Africa from stepping-up production. Because of the importance of manganese to the U.S.A. an attempt was made in 1948 to break the bottleneck by means of a triangular agreement whereby the U.S.A. supplied steel to Canada, Canada sent railway wagons to South Africa, and South Africa shipped manganese to the U.S.A. Thereafter production increased rapidly, reaching 964,127 tons in 1952[2] (Fig. 122).

At present all the Postmasburg deposits are being worked. On Aucampsrust many deposits have been found to extend to more than average depth, i.e. 75 to 100 feet, while farther west new ore-bearing strata has been located beneath a cover of Kalahari sand. The great world demand for manganese is such that low grade ore is saleable – of recent years about half the output has averaged less than 40 per cent manganese – while it has stimulated the exploitation of the 'black

rock[2] north-west of Kuruman, where manganese deposits of similar age and origin to those of Postmasburg protrude some 30 to 40 feet above the surface of the Kalahari sand. At present the Associated Manganese Mines Ltd, operating near Postmasburg and Kuruman, account for more than half the total production,[3] while six other companies work the deposits of the eastern belt and the Aucampsrust area.

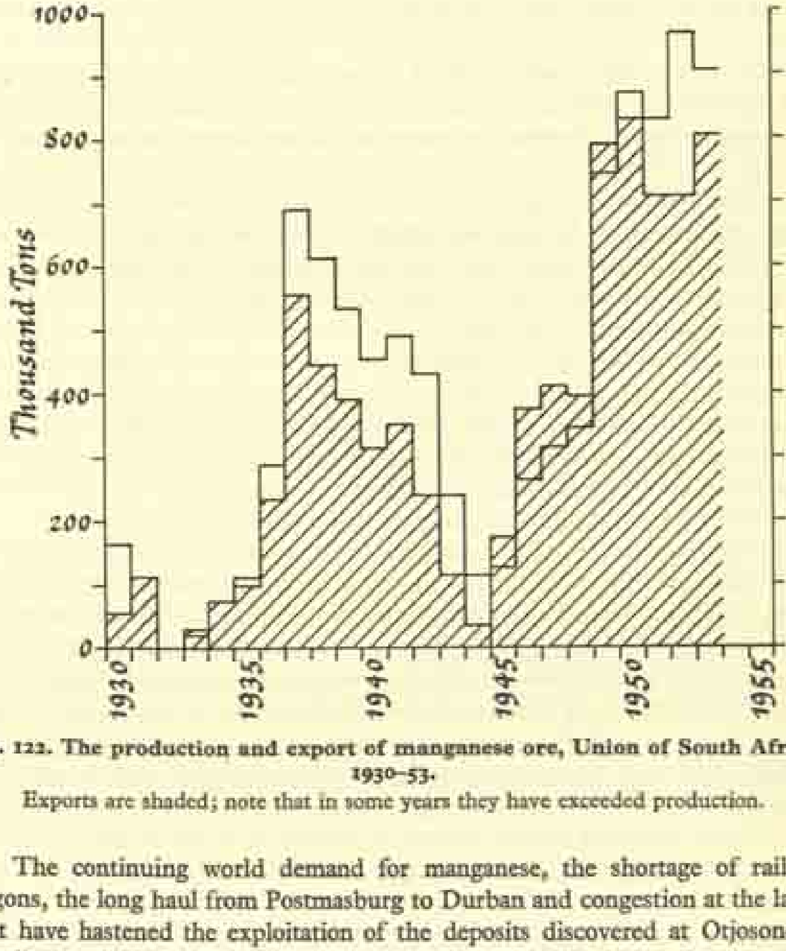


Fig. 122. The production and export of manganese ore, Union of South Africa, 1930–53.

Exports are shaded; note that in some years they have exceeded production.

The continuing world demand for manganese, the shortage of railway wagons, the long haul from Postmasburg to Durban and congestion at the latter port have hastened the exploitation of the deposits discovered at Otjosondu,[4] 80 miles north-east of Okahandja in South West Africa in 1940. The ore occurs within quartzites overlying the dolomite of the Damara system. The whole appears to have been isoclinally folded and then peneplaned so that today the quartzites repeatedly protrude through the level plain in a regular fashion to form a series of low hills with an E.N.E.–W.S.W. orientation.[5] The ore-bearing rocks are thus easily located. The ore occurs in shoots on two horizons, an upper one

averaging 10 to 80 feet thick and a lower one 2 to 10 feet thick, and since the shoots are of irregular occurrence mining activities will be spread in isolated units. A high proportion of the ore has a manganese content exceeding 48 per cent. Mining began in 1950 and by 1953 the output reached 40,655 tons,[6] most of which was exported through Walvis Bay to the U.S.A.

Chrome

During the past thirty years the discovery of an amazing variety of uses for chromic oxide, Cr_2O_3 – in metallurgy (ferro-chrome), in the manufacture of refractory bricks, and in the chemical industry (for the preparation of chrome compounds for the tanning, dyeing, pigment and electro-plating industries) – has occasioned a steadily increasing demand for chrome ore on world markets. In 1923 the world production stood at only 200,000 tons; by 1929 it had trebled; it declined at the onset of the world trade depression but recovered rapidly to exceed the 1929 figure by 1934 and reach 1 million tons by 1939. The war and post-war years brought greatly increased demands and by 1953 the world output stood at about 2 million tons. Throughout this period South Africa gained an increasing share of the world market.

South Africa possesses extensive reserves of chrome ore in the norite of the Bushveld Igneous Complex.[7] The ore occurs as sheets in the chromite sub-zone which extends from the Merensky Reef (see p. 315), downwards for 3,000 feet. The sheets conform to the general pseudo-stratification of the norite, outcropping around the rim of the Complex and dipping at angles of between 10° and 25° towards its centre. The main outcrops are in two belts of country – a western one extending over some 100 miles from Brits around the western rim of the basin to the Crocodile river and an eastern one extending over 70 miles from the Upper Dwars valley near Lydenburg, through Steelpoort and thence north-westwards to Malipsdrift on the Olifants river (Figs. 98 and 226). The ore 'seams' vary in thickness from an inch to over 6 feet and are remarkably persistent. There may be as many as twelve in any one area. In the east they occur in two groups – Lower and Middle – while in the west an additional group – the Upper – occurs near the Merensky Reef. Generally speaking the ore is of higher grade in the lower groups.

Mining operations depend both on the disposition of the ore 'seams' and the nature of the terrain.

In the western belt, where the landscape is that of a flat plain studded with inselberge, the ore is mined at shallow depths from incline shafts. By contrast, in the eastern belt, where the relief consists of parallel ridges and valleys, the ore outcrops along the eastern scarp faces of the ridges and is easily won from adits.

For industrial purposes chrome ore is classified as 'friable' or 'hard lumpy'. The former is preferred by the chemical industry and the latter for the manufacture of refractories, although 'friable' ore is increasingly used for chromite bricks and cements for patching and protecting furnaces. The metallurgical industry,

which provides the largest market, requires ore averaging over 45 per cent chromic oxide and low in iron. The Bushveld ores are mainly 'friable' and low to medium grade, averaging less than 44 per cent Cr_2O_3 and containing up to 27 per cent iron. 'Hard lumpy' ore, however, occurs south of Steelpoort and near Brits, while seams of high-grade ore averaging over 48 per cent Cr_2O_3 have recently been opened near the Northam – Thabazimbi railway. The Bushveld ores are used mainly in the chemical and refractory industries, their

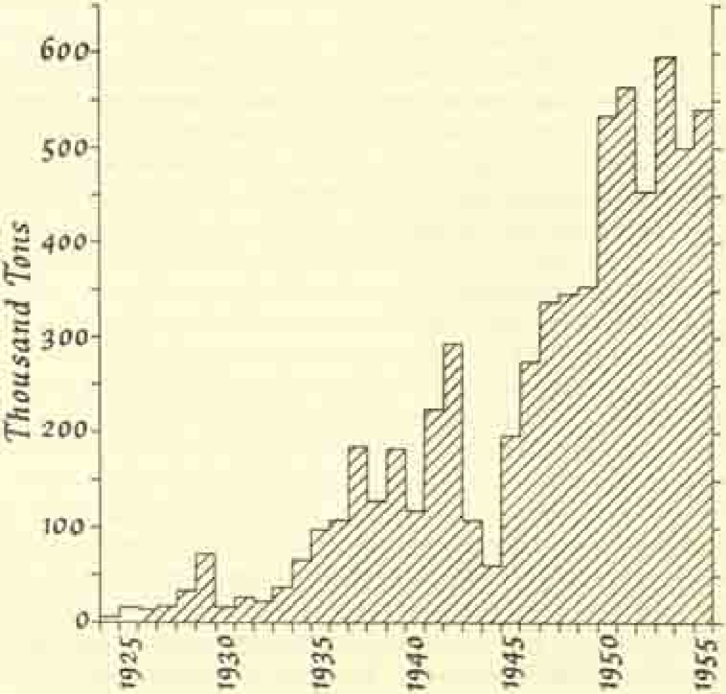


Fig. 123. The production of chrome ore in the Union of South Africa, 1924–55. Almost all the production is exported and in most years there is very little difference between production and export.

content of alumina (12–24 per cent), magnesia (12–18 per cent,) and silica, (4–5 per cent) making them highly suitable for the latter. Their high iron content is a drawback in ferro-chrome manufacture but with the general world shortage of high grade ore during recent years and the discovery of a satisfactory technique for concentrating the chromite, increasing quantities have been absorbed by this market.

Although the ores near Rustenburg were known as early as 1865 regular production began only in 1924. In the same year the railway was extended to Steelpoort and from 1927 onwards the eastern belt, with its shorter rail haul to

Lourenço Marques, the port of export, furnished the bulk of the export. By 1928 this reached 194,628 tons, an amount only exceeded by Southern Rhodesia, Turkey, and the U.S.S.R. The war brought increased demands and by 1942 the Union production reached 337,620 tons (Fig. 123). Thereafter an acute truck shortage on the railways restricted the output and the 1942 figure was not exceeded until 1947. In that year the Union furnished the U.S.A., the main consuming country, with 87 per cent of her imports of chemical grade chrome and 29 per cent of all her chrome ore requirements. The U.S.S.R. supplied the U.S.A. with over 50 per cent of her metallurgical chrome imports until 1949 when the amount was drastically reduced and the U.S.A. turned to other sources of supply. Production in South Africa increased rapidly, reaching almost 800,000 tons in 1953[8] when she became the world's leading producer.* In six years the production had more than doubled. This was aided by the discovery and exploitation of the high-grade deposits along the Northam–Thabazimbi railway and of lower-grade hard lumpy ore near Brits. At present the Steelpoort area supplies the bulk of the output but the western belt and particularly the area north of Northam is gaining in importance, the longer rail haul to Lourenço Marques – 487 miles from Tussenin siding compared with 355 miles from Steelpoort – being offset by the higher grade of the ore. Future production, however, depends partly on improved transport facilities. The heaviness of the ore and the high costs of maintaining gravel roads and bridges in areas of torrential thunderstorm rain limits operations to within a distance of 15 to 20 miles of the railway. Large quantities of high-grade 'hard lumpy' ore are known to occur in the Dwars river area south of Steelpoort, and along the Bier Spruit west of the Pilansberg (see Fig. 227), while the Chromite hills near the Olifants river represent a large potential source of supply. At present all these areas lack rail facilities, but only comparatively short extensions or branches from existing lines are needed to serve them. The total reserves of the Bushveld have been estimated at 200 million tons of ore averaging 40 per cent chromite, and with 40 million tons of grade saleable under present market conditions within 500 feet of the surface, increasing production may be expected.

Copper

Both by value of annual output today and by total value since the commencement of mining, copper ranks fourth after gold, diamonds and coal (Table 10).

Copper minerals occur in many localities in South Africa and were extensively worked by the early peoples,[9] but large-scale European mining has been confined to the deposits at Messina in the northern Transvaal and at O'Okiep and Nababeep in Namaqualand.

Copper was the first mineral to attract the attention of Europeans in the Cape

* In 1956 the Union production was exceeded by Turkey and the Philippine Islands. In most years these three countries and the U.S.S.R. produce roughly equal quantities of the world's chrome ore with Southern Rhodesia (output around 400,000 tons) as the only other large producer.

but although the Namaqualand deposits were known by 1685 (ch. 6, p. 103) the isolation and inhospitable desert nature of the area in which they occur discouraged exploitation until the latter part of the last century. The first successful mining took place in 1852; in the minor rush that followed 35 companies were formed,[10] but the lack of transport facilities restricted operations and many went under. The coming of the railways in the 1870's stimulated production and during the last two decades of the century, by which time activities had become concentrated in the hands of two concerns, the annual ore output averaged between 40,000 and 50,000 tons. At first the high-grade ore was exported to Britain for treatment but subsequently partial smelting using imported Welsh coke was undertaken on the spot and the matte containing between 40 and 50 per cent of copper was sent overseas for further smelting and refining.

In 1904 production commenced at the Messina mine but until 1913, when rail links with the Rand and Delagoa Bay were effected, the difficulties of the 170 mile haul by ox-wagon to the rail-head at Pietersburg limited the scale of operations.

Production from both areas increased during the first world war when high-grade matte containing up to 60 per cent copper was exported to South Wales for refining, but after the war falling copper prices and increasing ocean freights made the export of concentrates and matte uneconomic. This led to the virtual cessation of operations in Namaqualand in 1919 and at Messina in 1922 (Fig. 124), pending the installation of plant for the production of blister copper at O'Okiep and of fire-refined copper at Messina. Production recommenced in Namaqualand in 1922 and continued on a reduced scale until 1931 when the world trade depression brought operations to a standstill. The properties were acquired by an American company which re-equipped the mines with a view to reopening them when the copper price improved. This came with the outbreak of the second world war, since when production has steadily increased, reaching over 25,000 tons of blister copper in 1953. The Messina mines (Plate 62) recommenced operations in 1924 and maintained an expanding production even during the depression years to achieve a maximum output exceeding 18,000 tons of fire refined copper in 1950, since when there has been a slight decline, due mainly to greater attention to developmental work.

The nature of the deposits in the two areas differ. Those of Namaqualand consist of sulphide ores formed by direct magmatic segregation in dykes of norite or diorite intruded into gneisses and metamorphosed sediments. Altogether there are over 340 dykes but only half a dozen of them have supported successful mines. The O'Okiep mine works an irregular dyke over 1,000 feet long and 380 feet wide which has been worked to a depth of over 600 feet. The mines at Nababeep and Concordia also work large bodies of ore. The ore contains a number of impurities which necessitate electrolytic refining. Since the output is insufficient to warrant the establishment of an electrolytic refinery in Namaqualand the copper is exported in blister form. The reduction plants are located at O'Okiep and

Nababeep; smelting takes place at O'Okiep, while there are sulphuric acid plants at Nababeep. Since the resumption of mining activities in 1940 there has been a considerable increase in the proven reserves estimated at over 19 million tons containing 2·57 per cent copper in 1952.

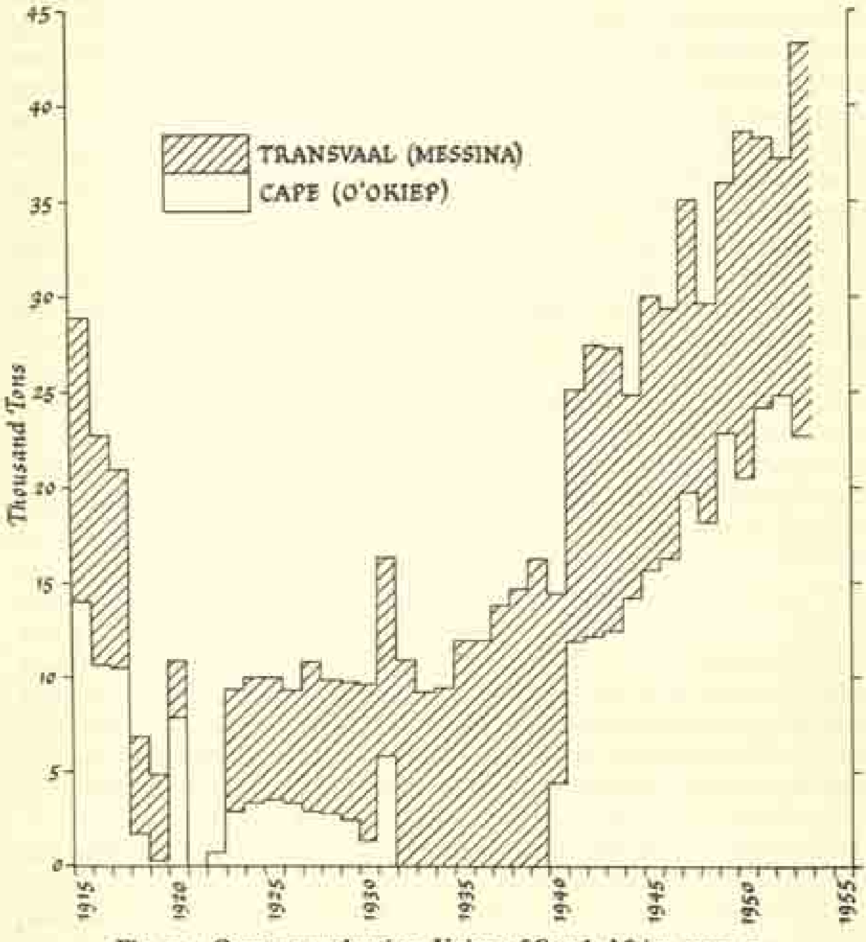


Fig. 124. Copper production, Union of South Africa, 1915–53.

The Messina copper ores occur as lodes in a mineralized strike-slip fault zone, from 500 to 1,000 feet wide, traversing the Old Granite in a south-westerly direction from the Limpopo through Messina and onwards for at least 20 miles. The mineralization was probably associated with the intrusion of a large bathylith to the immediate north-east in Southern Rhodesia in late Karoo times. The lodes are of considerable size, ranging up to 1,500 feet long and 100 feet wide, and contain large quantities of high-grade ore, the bulk of which is found in shoots at lode

intersections. The shoots are generally of limited extent but may be up to 500 feet long and 600 feet wide. A dozen lodes have been encountered in the Messina mine, the oldest in the area. There are three other producing mines, the newest of which – Artonvilla, to the east side of Messina – contains ore assaying up to 8 per cent copper in one of the three lodes so far located.[11] This mine only entered the production stage in 1950 while smelting commenced in 1952. At the Messina mine the workings have reached a depth of over 3,000 feet without any decrease in the richness of the ore. Although the mines are located in low-lying country, where the summer temperatures frequently exceed 95° F., conditions in the mines are comfortable.[12] Ventilating fans are essential but the temperature gradient below the surface is less than on the Rand mines. Hence the prospects for deeper level mining appear good. Each year, as development proceeds, there is an increase in the proven reserves, estimated in 1952 at nearly 4 million tons averaging 2·15 per cent copper. The ores are so remarkably free from deleterious impurities such as arsenic, bismuth, and antimony that it is possible to produce fire-refined copper ingots which fetch prices comparable with electrolytic copper. The presence of nearby deposits of coal (ch. 22, p. 374) makes possible fire-refining on the spot. Since 1951 the smelting facilities have been extended and provision made for the production of standard wire bars and special shapes in addition to ingots.[13] Water supplies are obtained from the Limpopo river, while electricity formerly generated at the mines and in short supply is now provided by the Electricity Supply Commission.

At the present day the demand for copper remains steady because no satisfactory substitute has been found for it in the ever-expanding electrical industry; consequently the return to free trading has not brought any appreciable fall in price. Hence the expansion of mining activities in the Union. In addition to the output of Namaqualand and Messina about 12,000 tons of copper is contained in the lead-zinc concentrates produced at the Tsumeb mine in South West Africa. An expansion of activities will bring a 60 per cent increase of output by 1954. A small copper mine is being developed north-east of Gravelotte in the northern Transvaal while active prospecting is taking place in South West Africa.

At present the bulk of the fire-refined copper and all the blister copper is exported while the Union imports electrolytic copper for her own industries from Northern Rhodesia. However with the expanding copper output and increasing industrialization the establishment of an electrolytic refinery at Vereeniging, capable of producing the Union's needs of 25,000 tons of copper per annum, is possible. This would still leave a surplus for export.

Tin

Tin was mined extensively in South Africa before the coming of the Europeans. Since 1905 when the ancient workings of the Rooiberg tin fields were discovered[13] tin mining has been carried on more or less continuously but except during the two world wars and again at the present day the output has been limited.

The most important deposits are associated with the Bushveld Igneous Complex,[14] occurring in pipes within the red granite, and as fissure lodes in the sedimentary rocks of the Rooiberg roof. Most important are the Zaaiplaats tinfields[15] 15 miles north-west of Potgietersrust and the Rooiberg and Leeupoort fields 40 miles west of Warmbaths.

The main output from the Zaaiplaats field has come from a series of 25 cassiterite pipes, uniting at depth into two major groups, and containing from 10 to 30 per cent metallic tin in some cases. Some of these pipes were followed to incline depths exceeding 2,500 feet, equivalent to a vertical depth of nearly 700 feet, before being abandoned. Most of them, however, are now practically worked out and the bulk of the present output comes from large bodies of low-grade ore – averaging less than 0·4 per cent metallic tin – occurring within a flat lenticular sill of microgranite associated with the intrusion of the Bobbejaankop granite. Discovered during mining operations in the 1930's the payable ore occurs in shoots which conform to the trend and pitch of the main pipe systems.

The Rooiberg and Leeuwpoort tinfields occur on the opposite flanks of a broad anticline, in which the ore bodies occur as lodes in fissures with an incline of about 60° from the horizontal. Mining has proceeded to a depth of over 700 feet on the incline.[16] The content of metallic tin from the three mines at present operating in the area averages about 1·5 per cent.

Small quantities of tin are produced from the tungsten-tin deposits near Upington. Tin was formerly won from replacement deposits along fissures at the Mutue Fides mine south-east of Potgietersrust and also from alluvial gravels along the Mbabane river in north-western Swaziland.

South African tin production reached its peak during the first world war when about 2,000 tons of metal were produced annually. As a war measure tin smelting began at Zaaiplaats in 1917 and later at Leeuwpoort but was discontinued with the return of peace-time conditions. Tin production fell during the inter-war years and in 1938 stood at little more than 500 tons of metal. Following the outbreak of war smelting recommenced at Zaaiplaats in 1940, since when, with the development of a home tinplate industry and uncertain conditions in South East Asia, efforts have been made to produce all the country's needs. Since 1950 new plant has been installed at Zaaiplaats[17] in order to increase the milling rate and improvements have been effected at Rooiberg. In 1953 the total output reached 2,400 tons concentrate and 927 tons of metallic tin.[18]

Other Metallic Ores

South Africa possesses reserves of a number of other metals, some of great strategic value and others important because they occur in the sterling block. Most important are antimony, nickel, vanadium, and tungsten.

Reserves of *antimony* occur in stibnite deposits in the Murchison range[19] between Leydsdorp and the Kruger National Park and again at Gravelotte in the Transvaal Lowveld. Antimony is used as a lead-hardening alloy in printing

metals and batteries, as a pigment for paint and in the manufacture of military shells. The world demand is normally very limited. The ores of the Murchison range contain gold and silver, for which they are normally worked, producing antimony only when the demand is strong and price high. This occurred during the two world wars, and the Korean war. The output increased from 24 tons in 1938 to 4,851 tons in 1944 and 7,990 tons in 1949. After the devaluation of the £ sterling in 1949 the price rose from £185 per ton to £390 per ton in 1951,[20] when the output reached 28,211 tons and South Africa became the leading producer of the western world and probably of the whole world. Subsequently, with peace in Korea, the price fell and the output declined to 12,958 tons in 1952,[21] and to 4,773 tons in 1953.[22] By 1956, however, it had risen again to over 14,000 tons which was considerably more than the estimated output of 8,000 tons from China, the next largest producer.

The most important *nickel*[23] deposits so far discovered in South Africa occur in the mountain ranges of Insizwa, Ingeli, Tonti, and Tabankulu, which rising to between 5,000 and 7,000 feet above sea-level and to over 3,000 feet above the general surface level, encompass Mt. Ayliffe in Griqualand West. Each mountain range consists of a basin-shaped mass of intrusive igneous rock between 1,000 and 3,000 feet thick resting on sedimentary rocks of Karoo age. In each gravity separation during cooling and crystallization has resulted in the accumulation of nickeliferous ore in crescentic lenses at the base. These lenses are thickest in the centre of the intrusion and taper outwards towards the sides of the mountains. The ores are identical with those of Sudbury in Canada. Two types[24] are present – (*a*) massive ore occurring in veins, sheets, and irregular bulbous bodies up to 200 feet long and 30 inches wide and containing 3·4 to 5·8 per cent nickel, 1·7 to 19·6 per cent copper, and small quantities of platinoids and (*b*) disseminated sulphide ore containing up to 1·0 per cent nickel, up to 1·1 per cent copper, and minute quantities of platinoids over an average thickness of 15 feet. The reserves of the former are limited and the individual deposits too small to work alone. For long the disseminated ore was considered of too low grade for economic exploitation but in 1950 mining operations began on Insizwa mountain, where the ore reserves are estimated at 2,000 million tons, one of the largest deposits in the sterling area. Further large reserves are contained in the other mountain ranges. The ore is easily mined from tunnels driven into the hillside and the nickel content increases with depth. The nickel can be satisfactorily concentrated by magnetic separation and flotation but it is planned to send the concentrate to refineries in Europe.

Nickeliferous ores similar to those of Insizwa occur also in pipe-like bodies in the Bushveld norite west of the Pilansberg. Here extensive exploratory and developmental work down to a depth of 500 feet has been undertaken, and it is claimed that over 150,000 tons of ore averaging 3 per cent nickel and 1 per cent copper have been proved. Massive sulphide ore is present in the centre of the pipes, but this grades to disseminated sulphide ore near the periphery.

At present Canada produces four-fifths of the world's nickel. New Caledonia and South Africa are the only other significant producers. Hitherto the South Africa output has been confined to the very small quantities obtained as a by-product from the Rustenburg platinum matte exported to the U.K. If the Griqualand and Bushveld ores can be successfully exploited, however, South Africa may become a major nickel producer.

South Africa is one of the few producers in the democratic world of *tungsten* or *wolfram* which although required only in small quantities is vitally important in the manufacture of hard steel. It is obtained from the minerals wolframite and scheelite which are found in pegmatites and similar rocks within reach of hydrothermal action from a granitic body. For many years small quantities have been recovered as a by-product in the reduction of the Bushveld tin ores. Mining for tungsten itself, however, began only in 1944 with the exploitation of wolframite occurring in veins in the ancient gneisses of the Kheis system[25] in Gordonia. These rocks outcrop in a narrow zone parallel to the Orange river, being sandwiched between the Namaqualand granite, the source of the mineralization. There are over fifty veins averaging 1 to 2 feet wide; some have been traced for hundreds of feet before disappearing beneath the cover of Kalahari sand. They are so close together that several may be worked from one drift; some have been proved to a depth of 70 feet without any decrease in the ore content. There are several mines working the deposits in open pits near the Windhoek railway west of Upington. In 1953 the output was only 421 tons[26] but this represented an important contribution to the production of the western world and especially to the sterling block; its value at over £340,000 exceeded that of tin. Small quantities of scheelite and wolframite are produced in South West Africa.

Lead[27] occurs as replacement deposits in the Dolomite in the southern Transvaal, particularly east of Zeerust, and in veins in the Dolomite north of Thabazimbi, in the quartzites of the Pretoria Series north-east of Pretoria, and in the norite near Argent. All these deposits have been extensively worked in the past, but the Union's reserves are small and quite inadequate for home needs. South West Africa has larger reserves. The main output comes from the complex copper-lead-zinc-silver ore of the Tsumeb mine, and from the vanadium-lead ore of the Abenab West mine.[28] In both cases the ore bodies occur within the Otavi dolomite.

At present South West Africa produces annually about 1,000 tons of *vanadium*, the output coming almost entirely from the Abenab West mine. This seemingly small amount represents an important contribution to the output of the western world in which the U.S.A. provides over half and Northern Rhodesia is the only other significant producer.

The serious production of *titanium* began only in 1953 when mining commenced in an ilmenite deposit, averaging 50 per cent titanium oxide, near Umkomaas. The reserves here are estimated at about 1 million tons but enormous reserves lie in the titaniferous iron ores of the Bushveld, the exploitation of

which awaits a satisfactory method of separating the iron and titanium. With titanium, the only metal that does not melt at supersonic speeds, in demand for the jet aircraft industry, research is being directed towards this end. Should success be achieved the working of the ores for iron and titanium with vanadium as an important by-product may be expected. Indeed Norway has been electrically smelting similar ores for some time simply for the recovery of vanadium. The most promising ore is the magnetite along the Steelpoort river in the eastern Transvaal,[23] and not far from the railhead at Steelpoort.

A newcomer to the list of metallic minerals produced in South Africa is *beryllium* which is used particularly in the atomic energy field as a moderator and neutron reflector as well as an alloying agent to harden and strengthen copper used in the production of aircraft, electrical equipment, and precision instruments. It is obtained from the mineral beryl which occurs in the pegmatites cutting the red granite in Namaqualand and South West Africa. The deposits have been known for a long time but until 1946 they were not worked owing to the absence of a market; this came with the new uses for the metal in the industrial field. Since 1946 progress has been so rapid that by 1950 the mines near Steinkopf in Namaqualand produced nearly 1,000 tons of beryl and contributed 40 per cent of the imports of the U.S.A., the largest consumer. The mines near Aus, Karibib, Okahandja, and Warmbad in South West Africa produced over 700 tons. Since then production has decreased somewhat in both territories, but to a lesser extent in South West Africa.

BIBLIOGRAPHY

Manganese

1. *The Mineral Resources of the Union of South Africa*. Dept of Mines, Govt Printer, Pretoria, 1940, pp. 262–75.
2. *Industrial Minerals*. Dept of Mines, Quarterly Report, Oct.–Dec. 1953, p. 47.
3. *Richmond's South African All Mining Yearbook*. 1953.
4. J. E. VILLIERS. 'The manganese ores of Otjosondu, South West Africa'. *T.G.S.S.A.*, Vol. LV, 1952.
5. 'Manganese in South West Africa. Deposits of the Otjiwarongo District'. *Industrial Minerals*. Dept of Mines, Quarterly Report, Jan.–Mar. 1952.
6. *Industrial Minerals*. Dept of Mines, Quarterly Report, Oct.–Dec. 1953, p. 77.

Chrome

7. W. KUPFERBURGER, B. V. LOMBAARD, B. WASSERSTEIN, and C. M. SCHWELLNUS. *The Chromite Deposits of the Bushveld Igneous Complex*. Dept of Mines, Geological Series, Bull. No. 10. Pretoria. 1937.
8. *Industrial Minerals*. Dept of Mines, Quarterly Report, Oct.–Dec. 1953.

Copper

9. *The Mineral Resources of the Union of South Africa.* Dept of Mines, Govt Printer, Pretoria, 1940, pp. 223–35.
10. R. LATSKY. 'Magmatic Copper Ores of Namaqualand'. *T.G.S.S.A.*, Vol. XLV, 1942, pp. 109–50.
11. 'Messina (Transvaal) Development'. *S.A. Min. Y.B.* 1951–2.
12. A. B. EMERY. 'Messina Copper Mining Industry'. *3rd Emp. Min. Metall. Cong.*, pt. 3, 1930, pp. 245–93.

Tin

13. *The Mineral Resources of the Union of South Africa.* Dept of Mines, Govt Printer, Pretoria, 1940, pp. 293–303.
14. A. L. HALL. *The Bushveld Igneous Complex of the Central Transvaal.* Geol. Surv. Mem. No. 28. Pretoria, 1932.
15. C. A. STRAUSS and F. C. TRUTER. 'Bushveld Granites in the Zaaiplaats Tin Mining Area'. *T.G.S.S.A.*, Vol. XLVII, 1944, pp. 47–78.
16. L. G. BOARDMAN. 'The Geology of a Portion of the Rooiberg Tinfields'. *T.G.S.S.A.*, Vol. XLIX, 1946, pp. 103–32.
17. Annual Reports of the Zaaiplaats Tin Mining Co. Ltd, published in the *S.A. Mining J.*
18. *Industrial Minerals.* Dept of Mines, Quarterly Report, Oct.–Dec. 1953.

Other Metallic Ores

19. *The Mineral Resources of the Union of South Africa.* Dept of Mines, Govt Printer, Pretoria, 1940, pp. 199–202.
20. Annual Report of the Consolidated Murchison Goldfields and Development Co. *S.A. Min. Surv.* 1951–2.
21. *Industrial Minerals.* Dept of Mines, Quarterly Report, Oct.–Dec. 1952.
22. *Industrial Minerals.* Dept of Mines, Quarterly Report, Oct.–Dec. 1953.
23. *The Mineral Resources of the Union of South Africa.* Dept of Mines, Govt Printer, Pretoria, 1940, pp. 280–7.
24. ANONYMOUS. 'Big Nickel Developments; Opening up the East Griqualand Deposits.' *S.A. Min. Eng. J.*, Vol. LXI, 1950, pp. 88–91 and 121.
25. J. W. von BACKSTROM. 'Notes on the Tungsten-Tin Deposit near Upington, Gordonia District'. *T.G.S.S.A.*, Vol. LIII, 1950, p. 35.
26. *Industrial Minerals.* Dept of Mines, Quarterly Report, Oct.–Dec. 1953, p. 47.
27. *Lead Deposits of the Union and South West Africa.* Geol. Surv. Mem., No. 39, 1940.
28. C. M. SCHWELLNUS. 'Vanadium Deposits in the Otavi Mountains, South West Africa'. *T.G.S.S.A.*, Vol. XLVII, 1945, pp. 49–76.
29. C. M. SCHWELLNUS and J. WILLEMSE. 'Titanium and Vanadium in the Magnetic Iron Ores of the Bushveld Igneous Complex'. *T.G.S.S.A.*, Vol. XLVI, 1943, pp. 23–38.

21

Non-metallic Minerals

The non-metallic minerals may be divided into two groups – (*a*) those of rare and localized occurrence, used mainly in basic and secondary industry – asbestos, corundum, mica, vermiculite, phosphate rock, salt, gypsum, mineral pigments, fluorspar, silica – and (*b*) those of common occurrence and mainly providing the raw materials for building and road making – limestone, (which, however, is used also in the iron and steel industry), granite and norite, sandstone, brick clays and shales, and slate.

The Industrial Minerals

Of these asbestos is of overwhelming importance. Together with vermiculite, mica, and corundum, the bulk of the output is exported. The other minerals in the group are mined for home consumption.

Asbestos[1]

Although in terms of output asbestos ranks eighth, in value it is exceeded only by gold, diamonds, coal, and copper. Mining began towards the end of the nineteenth century since when production has depended on world markets for the various types of fibre and on the discovery of new deposits as the earlier ones have become exhausted.

South Africa is unique in the possession of reserves of the three principal asbestos fibres – chrysotile, crocidolite or blue asbestos, and amosite, the latter two being almost entirely confined to the country. All three are non-inflammable, non-conductors of heat and electricity, practically insoluble in acids and are capable of being spun and woven into textiles, but because of slight differences with regard to these qualities they have somewhat different uses. Chrysotile is the most highly fire-resistant and its strong fine flexible texture makes it highly suitable for asbestos textiles, brake linings, and clutch facings as well as for insulation products, asbestos boards, and asbestos cement products. Crocidolite is less fire-resistant but withstands acids and sea-water better, has greater tensile strength and is more resilient. Hence it is used particularly in the manufacture of filter cloth, boiler mattresses, insulation packings, and increasingly for asbestos

cement products. Amosite has an exceptionally long fibre – lengths of 3 to 6 inches being common – and, being more resistant to sea-water and acids than chrysotile and more resistant to heat than crocidolite, is used mainly for spun materials for insulating purposes in ships and aircraft.

The most important chrysotile deposits occur in serpentines emplaced as ultra-basic intrusions in the Swaziland system in the eastern Transvaal and Swaziland. Two main belts of serpentine have been located; one extends over a distance of 50 miles from the Drakensberg Escarpment near Kaapsche Hoop eastwards across the Barberton basin to Malelane and has an average width of 2½ miles. Near Kaapsche Hoop this carries asbestos over a distance of 3 miles and supports the Amianthus and Munnik-Myburgh mines. The second belt extends over 31 miles from Havelock towards Steynsdorp (see Fig. 98) and supports the famous Havelock mine (Plate 63). The size of the ore bodies has warranted the establishment of large mines in each case. At the Munnik-Myburgh mine there are two fibre horizons, one of them nearly 15 feet wide. The individual seams are closely spaced – 15 to 30 per linear foot – and although the fibre averages only $\frac{1}{16}$ to ½ inch in thickness it is of superior quality. At the Amianthus mine the fibre is longer – 1 to 1½ inches. The deposits were first worked from tunnels driven into the Escarpment; but as mining became deeper dangerous roof conditions consequent on the softness of the rock were encountered. Depletion of reserves and mining difficulties led to the closing of these mines in the late 1930's. Recently, however, vertical shafts have been sunk to tap the deeper reserves and milling recommenced at the Munnik-Myburgh mine in 1951. The dried and bagged fibre is sent by a six-mile aerial cableway over the mountains to the rail-head at Elandsfontein. With the approaching exhaustion of the Amianthus mine, development work on the Havelock mine[2] began in 1937. Production started in 1939. The ore body extends for 4,000 to 4,500 feet and then pinches out rapidly. It averages 110 feet wide and dips southwards at 40° to 60°. The deposit was first worked in an open quarry and then followed underground. The mine is situated just within the borders of Swaziland in remote highly dissected mountainous country (Plate 63). In order to send out the bagged fibre and bring in supplies an aerial cableway, 12½ miles long, and rising over 2,500 feet to cross the Barberton Mountain Land, was erected to the nearest railhead at Barberton within the Union. At the same time all-weather roads were constructed over tortuous routes to Hectorspruit and Barberton. Power is generated at a diesel station. The annual output of the mine exceeds 30,000 tons fibre. Recently new quarries have been opened in a serpentine belt along the Msauli and Komati rivers[3] to the west, and in 1951–2 yielded nearly 6,000 tons of chrysotile fibre. Here power is provided by hydro-electric plants on the Msauli river.

In addition to the major deposits of chrysotile, small ore bodies occur in serpentine produced by contact metamorphism from dolerite sills in the Dolomite east of Carolina and near Pilgrims Rest.

The crocidolite and amosite deposits are found in banded ironstones of

lower Griquatown age in the Cape and the corresponding lower part of the Pretoria Series in the Transvaal. The Cape crocidolite fields lie in a belt of low hills stretching from 30 miles south of Prieska northwards past Kuruman to the Bechuanaland border, a distance of 250 miles. The Transvaal deposits lie in the mountains forming the northern rim of the Bushveld basin south-east of Pietersburg. In the Cape the individual deposits are generally small but in many cases the asbestos is easily won from surface workings. The fibre averages ¾ to 1 inch in length. Production is organized by two large companies – Cape Asbestos operating in the south with its centre at Koegas and Dominion Blue Asbestos operating in the north with its mills at Kuruman. The most important workings of the latter company comprise adits in the highly dissected country near the eastern edge of the Asbestos Mountains. Elsewhere, however, operations are confined to following outcrops until the seams become uneconomic. A large part of the output comes from tributors,[4] either individual natives or European miners with a gang of natives, who are paid on an asbestos output basis. The production from each rarely exceeds 20 tons per annum. This arrangement makes possible the recovery of asbestos from seams which it would not pay to develop systematically. A similar procedure is followed in the Transvaal, where, however, exploitation is more recent, and much of the ore is still recovered from open quarries. Generally speaking the Transvaal Blue is of less good quality than the Cape Blue.

Amosite occurs on the lowest crocidolite-bearing horizon in the Transvaal, being found at intervals over a distance of 60 miles along both banks of the Olifants river between Chuniespoort and the Steelpoort river (see Fig. 227). The fibre averages 4 to 5 inches and is easily and cheaply mined from adits. The bulk of the output comes from the Penge mine, whence it is carried 18 miles by road to the railhead.

Prior to the first world war only the deposits of Cape Blue asbestos were mined, the output being of the order of only 1,000 to 2,000 tons per annum. During the war the Penge amosite deposits, which had been discovered in 1907, were developed while operations began on the chrysotile deposits of the eastern Transvaal. During the 1920's with the development of the automobile industry in Europe and America, production expanded rapidly, the output of chrysotile and amosite overtaking that of Cape Blue. Peak production was reached in 1929 when the output stood at nearly 18,000 tons chrysotile, over 9,000 tons amosite, and about 6,000 tons Cape Blue (Fig. 125). The world trade depression then hit the industry and Russia dumped asbestos on an already overstocked market. Meanwhile, however, the leading asbestos firm of Turner and Newall acquired virtual control over the South African deposits, including those of Havelock which had been prospected in 1929. The effective control of 90 per cent of the British asbestos trade enabled the firm to secure an agreement with Russia regulating deliveries to the continental market.[5] After 1932 the total output increased but with the approaching exhaustion of the Amianthus and Munnik–Myburgh mines the output of chrysotile suffered a relative decline. In 1938 the total production

was 22,283 tons, comprising approximately equal quantities of the three types of fibre. The second world war and the post-war years brought greatly increased demands, while Russia, an important producer of high-grade chrysotile, ceased export. Production doubled in Canada, the world's leading producer, to more than 900,000 tons in 1956, the South African output increased fivefold to 121,893 tons and Swaziland with an output of over 30,000 tons entered the ranks of the

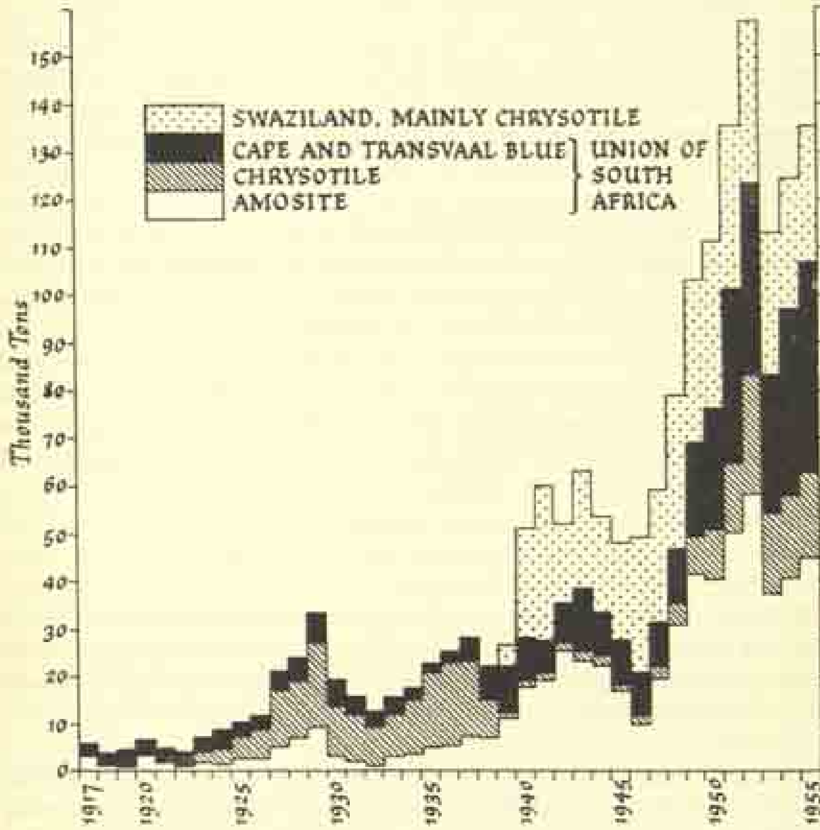


Fig. 125. The asbestos production of the Union of South Africa and Swaziland, 1917–53.

important producers. While the output of the South African producers including Southern Rhodesia, which accounted for over 106,000 tons in 1956, is far behind that of Canada, it consists mainly of high-quality long fibres suitable for spinning, whereas that of Canada comprises mainly short fibres. The demand for the South African product is therefore strong. In 1953 the Union produced 18,840 tons of chrysotile,[8] mainly from the Msauli–Komati area and from the older mines near Kaapsche Hoop. In the former locality reserves exceeding 6 million tons have

so far been disclosed. At Havelock the output exceeded 30,000 tons and the reserves already opened up total 14½ million tons. Further deposits undoubtedly occur in hitherto little prospected parts of the Transvaal and Swaziland. A striking feature has been the great increase in the production of amosite, totalling 38,258 tons in 1953, and 44,729 tons in 1956; this is associated with the demand in the aircraft industry; there has also been a great increase in the output of Transvaal Blue which at 16,824 tons approached that of Cape Blue, 20,883 tons in 1953. The more favourable location of Transvaal producing areas with regard to access to railways and port of export are largely responsible for these developments. Moreover large-scale mining is possible. With the installation of new milling and processing plant in course of erection at Pietersburg, designed to increase the revenue from crocidolite by about 30 per cent, continued expansion in the Transvaal seems assured.

Other Industrial Minerals

For many years South Africa has been an important producer of natural *corundum*,[7] an aluminium oxide which next to the diamond is the hardest natural mineral known and hence forms a valuable industrial abrasive and raw material for the manufacture of abrasive tools. Reserves of corundum are widely distributed over the northern and north-eastern Transvaal and are found also near Kranskop in Natal and Steinkopf in Namaqualand. They occur as primary deposits in the Old Granite and accompanying pegmatites and also in the ancient basic igneous rocks in proximity to these intrusions. Owing to the resistance of corundum to weathering eluvial deposits frequently cover the primary corundum-bearing rocks. They are of more widespread distribution than the primary deposits and for many years they furnished the bulk of the output, the method of recovery consisting simply of the screening and concentration of the crystals by washing in rotary pans. Of the primary deposits only those which have become soft, in consequence of weathering, so that the crystals are readily obtained, are worked. Exploitation began in 1912 since when the output has fluctuated with world economic conditions. During recent years it has varied between 2,000 and 5,000 tons, mainly of crystal for U.S. markets. The deposits are worked in the Pietersburg, Soutpansberg, and Letaba districts by numerous diggers, who sell to two large companies, one of which maintains a mill at Pietersburg and buying depots at Bandolier Kop and Louis Trichardt.[8]

Since the beginning of the century small quantities of *mica*[9] have been won from muscovite-bearing pegmatites located in a belt from two to four miles wide extending from Mica Siding in the north-eastern Transvaal eastwards for about 50 miles towards the Mozambique border. Owing to the combination of perfect cleavage, transparency, flexibility, toughness, low conductivity to heat and electricity, and stability when subjected to high temperatures and rapid changes of temperature, this mineral is of vital importance in the electrical industry. The small output of sheet mica is absorbed mainly by the local market but since 1924

large quantities of waste mica suitable for grinding have been exported to the U.S.A. More important, however, are the extensive deposits of *vermiculite* or 'rotten mica' at Loolekop, Palabora, some 25 miles east of Mica Siding. The vermiculite occurs along with apatite in pyroxenes and serpentines; the deposits had been known to be phosphate bearing since 1906, but it was not until 1936 that their vermiculite content was recognized.[10] Intensive prospecting followed and the reserves are now known to be the largest of their kind in the world, one vermiculite serpentine mass to the north of Loolekop being classed with Libby, Montana. This mass contains innumerable bodies of pure high-grade vermiculite up to 30 to 40 feet wide and hundreds of feet long. The rock, however, requires blasting and at present the major output comes from the area south of Loolekop where, although the body is of lower grade permitting only a 25 to 30 per cent recovery, the vermiculite is more easily won. It occurs in pyroxene which is so loose and friable that blasting is unnecessary, the material being cheaply won by pick and shovel in open pits. Covered by only 2 to 3 feet of overburden it extends down to 70 feet when it changes to phlogopite which yields sheet mica. The production of vermiculite, which is used mainly for thermal and acoustic insulation, has increased since 1945 when it stood at 1,411 tons to reach 46,763 tons in 1950.[11] Since then there has been a slight decrease in the total output but an increase in the value. In 1953, 34,324 tons were exported mainly to the United States and United Kingdom and brought in over £200,000.[12]

The apatite deposits were worked between 1930 and 1934. The rock was crushed and ground and the phosphatic material concentrated by a flotation process. The raw rock phosphate thus obtained was screened and the resultant product sold as 'Phosmeal' with a guaranteed phosphoric oxide content of 36 per cent. The venture, however, proved uneconomic and operations ceased in 1934, when about 5,000 tons had been produced. Apart from this small output and limited quantities of guano obtained from the islands off the west coast, no phosphate rock was produced in South Africa before the war despite the great need for phosphatic fertilizers in the country. Instead large quantities of rock phosphate were imported to feed local fertilizer factories while, in addition, superphosphates were imported. The war produced a crisis in the fertilizer industry and prompted an organized effort to develop the local reserves of phosphate rock. This culminated in the acquisition of the Palabora apatite deposits by the Government in 1951 and the establishment of the Phosphate Development Corporation Ltd (FOSKOR). The deposits are now being worked in open pits carrying a face of about 35 feet in depth. A factory has been established at Palabora for the production of concentrates averaging 34 to 36 per cent oxide (P_4O_5). Meanwhile deposits of lime phosphate near Langebaan Road in the south-west Cape have been opened by the African Metals Corporation to supply their fertilizer factory in Cape Town. As a result of these developments the output of phosphates has risen sharply, exceeding 100,000 tons in 1952, of which rather more than half came from Palabora. It is intended to increase production from this source alone

to 450,000 tons per annum, which will be adequate for home requirements. These reserves are sufficient at this rate of working to last 140 years. Further reserves of lime phosphate occur near Saldanha Bay where their formation has been due to the action of liquids from former superincumbent guano deposits, on old shelly beach deposits; the reserves, however, are scattered and of low grade. Large reserves of iron and aluminium phosphate occur in the same area but so far no method of converting them into soluble form for use as fertilizers has been found.

No important deposits of *nitrates* have so far been discovered in South Africa and, apart from synthetic nitrates, the chief sources of nitrogen are sea-bird guano, of which between 6,000 and 8,000 tons are collected annually from islands off the west and south coasts, and air-dried bat droppings from limestone caves in the Transvaal and South West Africa.

The *salt* produced commercially in South Africa is obtained from saltpans or shallow depressions in which saline waters accumulate and become concentrated by solar evaporation.[13] The saltpans occur along the coast north of Swakopmund and near Port Elizabeth and also in the interior, in the area bounded by Vryburg, Bloemfontein, and Britstown, where they represent the relics of former river systems which have become areas of inland drainage (ch. 39, p. 611). In some cases the salt crust formed on the pans during the dry season is simply scraped off and collected; more frequently, however, boreholes are sunk in the pans and the brine pumped into evaporating ponds where the salt crystallizes out. The output, at between 150,000 and 200,000 tons per annum, is sufficient for home needs and for a small export to the territories farther north. Small quantities of *soda* ash were formerly obtained from a soda caldera north-west of Pretoria but in 1951 operations were suspended pending the results of investigations into working the brine for coarse and table salt. *Gypsum*[14] also occurs in pan deposits in the Kimberley and Boshof districts and as crystal aggregates within clay subsoil around Van Rhynsdorp. The known reserves within reach of railways total millions of tons but the quality is inferior. It is used mainly in the manufacture of Portland cement and, when calcined, in the manufacture of products in which a dead-white colour is not essential. The main output comes from the vicinities of Winsorton and Van Rhynsdorp and has more than doubled since 1945, the increase paralleling the expansion of the cement industry. Small quantities are exported to the Rhodesias.

Since 1930 the production of *mineral pigments*[15] has become quite important. The output consists mainly of yellow ochre obtained from the Bokkeveld shales in the Riversdale district of the Cape with smaller quantities of red oxide from a sideritic ironstone occurring in the Coal Measures near Utrecht, Dundee, and Newcastle, and umber from the Dolomite near Krugersdorp. Before the war most of the output was exported in crude form but refining plants have now been established in the Union.[16] They deal annually with between 5,000 and 8,000 tons of yellow ochre and smaller quantities of oxides and umber. Most of the yellow

ochre is exported, mainly to the United Kingdom, but the other pigments are produced mainly for home consumption.

Apart from limestone, fluorspar and silica are the most important non-metallic minerals used in the iron and steel industry. *Fluorspar*, used to lower the melting point of the flux, is widely distributed in the Transvaal; it occurs either alone or associated with lead and zinc ores in veins and large irregular bodies formed by replacement of the Dolomite, particularly south of Zeerust, and also as a gangue mineral in the tin deposits of the Bushveld.[17] The output has come mainly from the former. The fluorspar is of high grade, some of it being suitable for optical purposes. Until 1934 it was worked mainly for export. With the growth of the South African iron and steel industry, however, home needs have increased; production has risen in the Zeerust area, deposits near Naboomspruit have been opened up, and since 1950[18] the Industrial Minerals Exploration (Pty) Ltd, a subsidiary of Iscor, has developed an extensive low-grade deposit in the Otjiwarongo district of South West Africa. In consequence of these developments the Union production has increased from 1,615 tons in 1934 to 16,029 tons in 1953[19] while South West Africa produced 5,641 tons in 1953. *Silica* used for refractory bricks for furnace linings is obtained mainly from silcrete in the Mossel Bay and Riversdale[20] districts of the Cape, and from decomposed granite near Mica Siding; silica sands both for refractories and for glass making occur in the Moot valley separating the Daspoort and Magaliesberg ranges near Pretoria,[21] in the Cape Flats, and in a thick bed of sandstone at Talana Hills, Dundee. Other materials used in the manufacture of refractory bricks include chromite (see ch. 20, p. 325), fireclay contained within the Coal Measures and worked for bricks, crucibles and other refractory products at Boksburg, Olifantsfontein, and Vereeniging,[22] and magnesite, formed by the weathering of basic igneous rocks and quarried near the Pretoria–Lourenço Marques railway east of Kaapmuiden and also in the Lydenburg district. The production of all these materials has expanded rapidly since 1945 – that of silica, from 5,176 tons to 147,248 tons in 1953, being quite spectacular.

The Common Minerals

Limestone and Marble

Limestones[23] are found in various stages of consolidation and recrystallization in South Africa. Sand limestones of Tertiary or Recent age are found along the south-east coast of the Cape Province, true limestone is present in the Dolomite of the Transvaal system which covers wide areas in the Transvaal and Bechuanaland, and marble occurs in xenoliths of ancient metamorphosed calcareous sediments both in the Old Granite and the Younger Granites and as travertine deposits near Port St John's and Mafeking.

Limestone is used as a flux in the iron and steel industry, in lime burning, cement manufacture, the chemical industries and agriculture and to a lesser extent as a road metal and building stone. In contrast to the countries of western

Europe, limestone is rarely used for building purposes in South Africa while its use as a raw material in industry is comparatively recent. Before 1936 the amount quarried was negligible. By 1946 it had increased to more than 2½ million tons and by 1953 to over 5 million tons. This increase has been due to the development of the cement and concrete industry (see ch. 31, p. 471), the increased needs of the growing iron and steel industry (see ch. 25, pp. 407–9, the heavy demand for building lime during the post-war years and the more general use of agricultural lime.

Both in the Transvaal and in the Cape the Dolomite is mainly a magnesium limestone suitable, when burnt in ordinary kilns, for the production of common blue building lime. Reserves of pure limestone are of relatively limited occurrence. For long the requirements of the chemical industry and the cyanide works on the Rand were met by the small quantities of pure white lime obtained from stalagmites and cave fillings. At Taungs, however, there is a large deposit of pure white limestone, totalling over 7 million tons, which provides a source of metallurgical limestone, which until its discovery had been scarce. Vast areas of the country are covered with desert limestone but this usually contains up to 20 per cent silica and while it is used for cement manufacture at Pretoria and Mafeking and in the Orange Free State it is unsuitable for other purposes.

The most important marble deposits occur in the Transvaal Bushveld. At Marble Hall a large xenolith of Dolomite within the red Bushveld granite contains a large variety of excellent quality marbles, including some suitable for use as metallurgical limestone. The deposit is also worked for building stone. A similar Dolomite xenolith in the red Bushveld granite north of Beestekraal also contains excellent marbles but its isolation from a railhead has so far precluded its exploitation. More accessible marble deposits are worked for building stone and lime near Belfast, where there is a serpentinized calcareous bed in the Magaliesberg shale, at Van Rhynsdorp, where the Malmesbury Series contains metamorphosed limestones, and near Port St John's where travertine deposits are worked along the Umzimvubu river down which the quarried material is carried to the coast.

BIBLIOGRAPHY

1. A. L. HALL. *Asbestos in the Union of South Africa*. Geol. Surv. Mem., No 12. (Revised). Govt Printer. Pretoria. 1930.
2. 'The Havelock Mine'. *S.A. Min. J.*, Vol. XXXVII, 1947–8.
3. *Richmond's South African All Mining Yearbook*, 1953, p. 28.
4. *S.A. Min. Y.B.* 1950–1.
5. *Mining and Industrial Magazine*. Vol. IX. London. 1933.
6. *Industrial Minerals*. Dept of Mines, Quarterly Report, Oct.–Dec. 1953, p. 47.
7. *The Mineral Resources of the Union of South Africa*. Dept of Mines, Govt Printer, Pretoria, 1940, pp. 404–10.
8. *Richmond's South African All Mining Yearbook*, 1953, pp. 193–4.

9. *The Mineral Resources of the Union of South Africa*. Dept of Mines, Govt Printer, Pretoria, 1940, pp. 437–40.
10. T. W. GEVERS. 'Vermiculite at Loolekop, Palabora, North-east Transvaal'. *T.G.S.S.A.*, Vol. LI, 1948, pp. 133–78.
11. *Richmond's South African All Mining Yearbook*, 1953, p. 517.
12. *Industrial Minerals*. Dept of Mines, Quarterly Report, Oct.–Dec. 1953.
13. *Official Yearbook of the Union of South Africa*, No. 26, 1950, p. 1017.
14. *The Mineral Resources of the Union of South Africa*. Dept of Mines, Govt Printer, Pretoria, 1940, pp. 421–4.
15. *The Mineral Resources of the Union of South Africa*. Dept of Mines, Govt Printer, Pretoria, 1940, pp. 441–4.
16. *Official Yearbook of the Union of South Africa*, No. 26, 1950, p. 1016.
17. *The Mineral Resources of the Union of South Africa*. Dept of Mines, Govt Printer, Pretoria, 1940, pp. 411–14.
18. *Official Yearbook of the Union of South Africa*, No. 26, 1950, p. 1263.
19. *Industrial Minerals*. Dept of Mines, Quarterly Report, Oct.–Dec. 1953.
20. *The Mineral Resources of the Union of South Africa*. Dept of Mines, Govt Printer, Pretoria, 1940, pp. 354–5.
21. L. MEINTJES and H. J. NEL. *Glass Sands of an Area near Pretoria*. Dept of Mines. Geol. Ser., Bull. 17. 1947.
22. *Official Yearbook of the Union of South Africa*, No. 26, 1950, p. 1014.
23. *The Mineral Resources of the Union of South Africa*. Dept of Mines, Govt Printer, Pretoria, 1940, pp. 434–5.

22

Coal[1]

While the importance of gold and diamonds in the pioneer development of South Africa is generally recognized, it is not always appreciated that the existence of coal, which could be mined cheaply, made possible the large-scale production of these minerals and at the same time contributed to the economic advancement of the country. Today coal is of ever greater importance for not only does it yield one of the raw materials for the iron and steel industry, but it provides the basis for all the major fuel and power developments in the country. It thus forms the backbone for continued economic progress.

The Discovery of Coal and Growth of Mining

Although there are no records of early coal working in the country, it is probable that the outcrop seams were dug by the Natives and by the early European colonists. About 1840 coal was being worked in Natal and small quantities were taken by ox-wagon to Pietermaritzburg for sale. In 1852 three tons were sent to Durban to be tested for bunkering purposes; but they proved unsuitable. Coal was discovered at Cyfergat[2] in the north-east of the Cape Colony in 1859 and five years later a colliery was started near Molteno. Shortly afterwards the opening of the Kimberley diamond mines stimulated coal mining in this area, but the coal was of poor quality and after the discovery of better coals in the Transvaal and Natal operations declined. The first record of coal working in the Transvaal dates from 1868 when farmers in the Bethal district were reported to be mining it for domestic use.[2] Eleven years later coal was discovered on the banks of the Vaal river near Vereeniging, and small quantities were transported some 300 miles by ox-wagon to the Kimberley diamond mines. The first serious attempts at establishing a coal mining industry, both in Natal and the Transvaal, followed the opening of the Witwatersrand goldfield. In Natal the demand for locomotive fuel on the railways and the expense of importing Welsh anthracite prompted an investigation of the Colony's coal resources and led to the opening of a number of collieries around Dundee in the Klip river coalfield in 1888. In 1889 their output was 26,862 tons; in the following year it reached 107,555 tons.[3] The import of Welsh

coal then ceased. In the Transvaal the needs of the gold mines provided the stimulus and the opening of collieries went hand in hand with the extension of the railways. Thus as the Rand line was extended eastwards from Johannesburg, coal mines were opened at Brakpan and Springs, then around Witbank, and after the Anglo-Boer war at Breyton and Ermelo.

The subsequent development of the coal mining industry has been very largely influenced by the changing demands of such highly selective markets as the

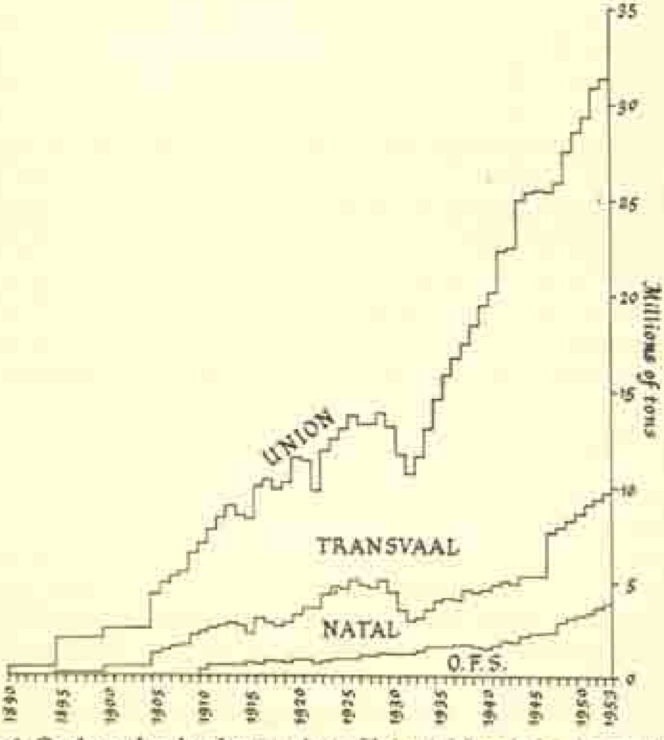


Fig. 126. Coal production by province, Union of South Africa, 1890–1953.

mines, the railways, the bunker and export trade, the iron and steel industry and the electricity generating stations. Compared with western Europe and North America the domestic fuel market has in consequence of the generally warm climate been relatively unimportant. In Natal the output soon exceeded the needs of the railway and by 1898 195,314 tons were used for bunkering purposes at Durban, while 6,043 tons were exported, 1,722 tons being sent to ports outside Southern Africa. The bunkering trade expanded until at the outbreak of the first world war over 2 million tons were used annually for this purpose. Subsequently, however, the increase in the size of all ships and the general changeover from coal-burning to oil-burning engines reduced the demand. After 1918 exports

averaged over 1 million tons annually but with the return to peace-time conditions Natal coal could not compete with the superior Welsh steam coals in export markets. The market for coking coal remained small in the absence of a large iron and steel industry while the demand for steam coal consequent upon the extension of the railways in Natal was to some extent offset by the progressive electrification of the Durban–Johannesburg line. While the Natal collieries, largely dependent on uncertain export and bunker markets, had difficulty in disposing of their coal, those of the Transvaal catering mainly for the inland markets of the mines and railways experienced little trouble. From the end of the Anglo-Boer War until 1929 the Union production increased steadily from about 3½ million tons to almost 14 million tons, with Natal contributing about 35 per cent of the total and the Transvaal 58 per cent (Fig. 126). After Union the Cape production fell to an insignificant amount while that of the Orange Free State remained small owing to the poor quality of the coal. The output declined during the depression years of the early 1930's but following the establishment of the iron and steel works at Pretoria and the erection of electricity generating stations near the Vaal river, it increased steadily to 17½ million tons in 1938. The Transvaal, deriving most benefit from these developments and producing mainly 'blend'* coking coals and smalls and slack, accounted for the greater part of the increase, while in Natal the increase in output was small owing to the limited quantities of 'straight' coking coal required by the iron and steel works and the restricted nature of the export markets.

Table 15. Union of South Africa. Coal Output by Provinces, 1918–1953

	1918		*1928*		*1938*		*1953*	
	Output (short tons)	(%)	*Output (short tons)*	(%)	*Output (short tons)*	(%)	*Output (short tons)*	(%)
Cape	4,654	0·5	5,059		3,108			
Natal	2,607,133	26·3	4,641,145	34·6	4,447,977	25·4	5,754,344	18·3
Transvaal	6,438,961	64·7	7,669,102	57·2	11,518,304	65·6	21,666,396	69·1
O.F.S.	826,577	8·5	1,088,109	8·1	1,566,838	8·9	3,950,281	12·6
Union	9,877,325	100·0	13,403,415	100·0	17,536,227	100·0	31,371,021	100·0

Since 1938 the Union coal production has nearly doubled, the 1953 output exceeding 30½ million tons. With the exception of the U.S.A. in no other important coal producing country has there been such a spectacular increase during recent decades and while the present output is only one-eighth that of the British Isles, it compares with that of Belgium and makes South Africa the leading producer in the southern hemisphere (Table 16). The great increase in production has resulted from the continued expansion of the iron and steel industry, the greatly increased demands of the power stations and railways associated with the

* 'Blend' coking coal is coal with caking propensities which however must be mixed or blended with true or 'straight' coking coal for the production of metallurgical coke.

Table 16. Output of Coal by Leading Producing Countries, 1935–1955

	Million Tons					
	1935	*1940*	*1945*	*1950*	*1953*	*1955*
U.S.A.	379·11	457·37	562·40	497·34	433·38	439·45
U.K.	222·25	224·30	182·78	216·32	224·20	221·56
Germany, East and West	130·31	236·71	36·10	111·77	125·56	131·71
France	45·48	38·70	32·79	50·03	51·76	54·46
Japan	37·16	55·41	21·98	37·85	45·80	41·75
India and Pakistan	23·52	29·39	29·17	32·74	36·56	38·77
Belgium	26·08	25·13	15·63	26·89	29·59	29·50
Canada	9·21	14·70	13·37	15·12	12·39	11·17
Australia	10·88	11·73	12·79	16·54	18·41	19·33
South Africa	15·48	16·91	23·18	26·06	28·34	31·73
U.S.S.R.	102·16	163·34	137·76	207·00	244·08	383·84

In each case 1 ton = 2,240 lb.

British Iron and Steel Federation's Statistical Yearbook for 1954 (1956).

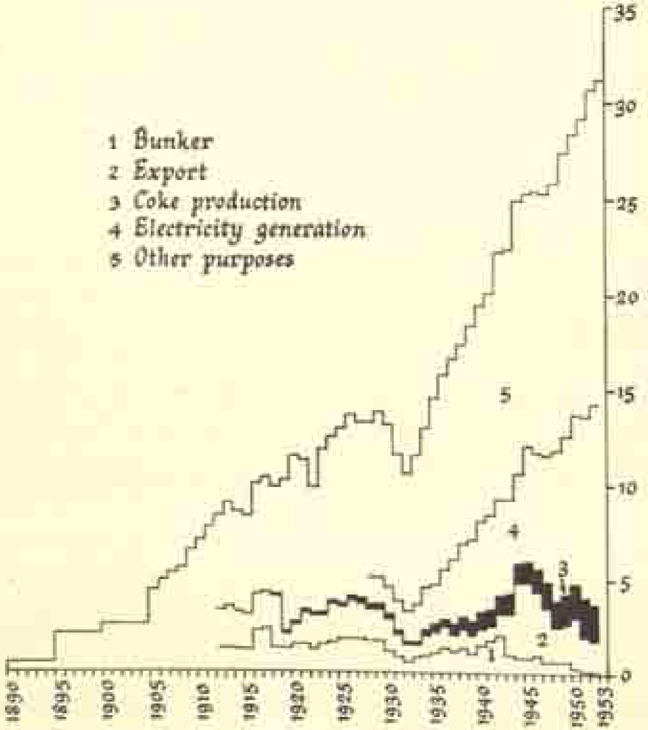


Fig. 127. The main markets for South African coal, 1890–1953.

development of the Orange Free State and Klerksdorp goldfields and the growth of secondary industry, and the opportunities in bunker and export markets (Fig. 127). The greater part of the increase is accounted for by the Transvaal, which with an output in 1953 of almost 20 million tons, nearly double the 1938 figure, contributed nearly 70 per cent of the Union total, while the Orange Free State, finding a market for her poor quality coals in the power stations and more recently in the oil-from-coal project at Coalbrook, has become an important producer yielding nearly 4 million tons or 12 per cent of the total. The Natal production has increased only slightly so that her relative contribution has declined to 18 per cent.

The Disposition of the Coalfields

The chief deposits of coal are contained in the coal measures of the Middle Ecca Series of the Karoo System in the south-eastern Transvaal, Natal, and the Orange Free State; important deposits occur also in the Upper Ecca Series in the Waterberg district of the northern Transvaal, while coal of inferior quality is found in beds of Beaufort age around Somkele in Zululand and in the Stormberg Series in the Cape province.

The coal measures of the Middle Ecca consist of sediments varying in coarseness from conglomerates to shales, with sandstones and grits predominating. The Upper Ecca beds are mainly shales while sandstones characterize the Beaufort and Lower Stormberg Series.

The manner in which the coal measures accumulated is uncertain but they were probably laid down unconformably on the uneven floor of an area of fluviatile flats which developed at the close of the Dwyka glacial period between a receding highland area to the north and east of the Transvaal, and the Cape geosyncline to the south[4] (see ch. 1, p. 11) and extended over rocks ranging in age from the Old Granite to the Dwyka conglomerate and Lower Ecca shales. Because of the unevenness of the floor the lower beds, including valuable coal seams, are missing from some areas; the upper beds are more extensive. The coal measures were subsequently buried by great thicknesses of sandstone, shales, and lavas of later Karoo age, while the whole underwent deformation as a result of warping along the Lebombo, Griqualand–Transvaal, and Soutpansberg axes during Tertiary times. In consequence of these movements and of subsequent erosion over a long period of time the coal-bearing rocks are preserved today only in certain areas designated coalfields (Fig. 128).

The coalfields of the Orange Free State, the southern and eastern Transvaal, and Natal are located around the rim of the great Karoo–Basutoland depression, where the coal measures, if ever laid down, lie buried beneath great thicknesses of later Karoo rocks. The conditions under which the coal measures accumulated varied from place to place while subsequent erosion has removed them from large areas, thereby producing a number of distinct coalfields. The remaining fields are detached, being preserved only between the axes of Tertiary upwarp.

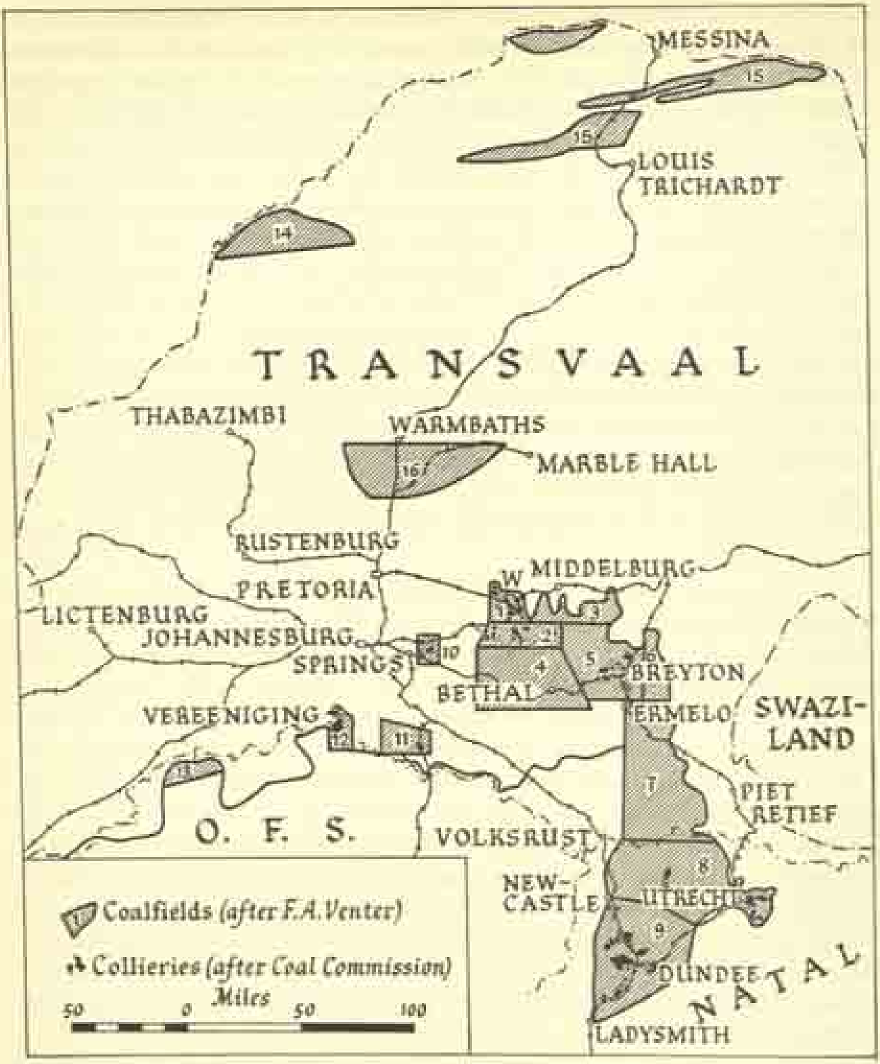


Fig. 128. The distribution of the main coalfields and collieries of the Union of South Africa.

1. Witbank. 2. Southern Witbank. 3. Middelburg, Belfast and Eastern Witbank. 4. Bethal. 5. Breyton. 6. Lake Chrissie. 7. Ermelo-Piet Retief. 8. Northern Natal. 9. Klip River. 10. Springs. 11. South Rand. 12. Vereeniging–Clydesdale. 13. Vierfontein. 14. Waterberg. 15. Soutpansberg. 16. Springbok Flats.

The coalfields of South Africa differ in a number of important respects from those of Europe. In the first place they are of younger age, ranging from Permian to Trias. Secondly the coal seams occur in predominantly sandy formations; 'underclays' are commonly absent, but shales or even sandy bands frequently

occur within the seams. This led to the belief that all South African coals were of drift origin, but this view has been partly negatived by the occasional occurrence of plant stumps and roots in their position of growth[5] and by the persistent character of some of the seams. Thirdly the seams are relatively thicker and lastly they are little disturbed. In most cases they are horizontally disposed and even in proximity to the axes of uplift are only gently tilted. The coalfields are relatively free from faulting and the main problems are associated with igneous intrusions, particularly in Natal.

The Classification and Grading of South African Coals

Coal is usually classified on the basis of its content of fixed carbon and volatile matter into four main types: anthracite, bituminous or humic, semi-bituminous, and lignite. Small quantities of anthracite occur in the Natal and eastern Transvaal coalfields but most of the South African coals are bituminous. Those of Natal with a fixed carbon content between 75 and 80 per cent and containing less than 10 per cent volatile matter are of high rank and excellent for bunkering purposes. Those coals of Natal and the Transvaal averaging between 55 and 60 per cent fixed carbon and between 20 and 30 per cent volatile matter are of lower rank but are suitable for steam raising purposes on the railways and in industry, while some of them have caking propensities. Coals of still lower rank, such as occur widely in the Transvaal and Orange Free State, are suitable for use in the electricity generating stations. Generally speaking coals with a high volatile content suitable for gas making are of very limited occurrence. All the South African coals suffer from a high ash content, resulting from the occurrence of shale bands within the coal seams, a characteristic which even careful washing fails to eliminate.

The coals with caking propensities are classified as 'straight' or 'blend' coking coals according to whether they may be used alone or must be blended with superior coal for the production of metallurgical coke (see p. 379).

Until recently South African coals have been used mainly for steam raising and general heating purposes and hence the qualities of most importance have been those closely related to boiler practice.[6] The calorific value or the heat of combustion – usually expressed as lb. of steam generated per lb. of coal at 100° C. – has been the first attribute and consequently coals have been graded according to this criterion. Grading was first introduced in terms of the Coal Grading Act of 1922 in order to encourage the export trade and to counteract the damage to reputation caused by the export of inferior coal to overseas markets. In Natal the standard adopted for first-grade shipment coal was a calorific value of 13·5 lb./lb., in the Transvaal one of 12·8 lb./lb. In 1939 the calorific value for first-grade Natal shipment coal was reduced to 13·1 lb./lb. and in 1942, in order to cater for the enlarged export market, it was further reduced to 12.8 lb./lb. In 1945 the Fuel Research Institute recommended to the Coal Commission that in view of the sale of coal for bunker purposes a minimum volatile matter content of 14 per cent

should be adopted and pointed out that in Europe constituent ash and moisture contents of coal for steam raising purposes were also considered. These recommendations, however, were not accepted. Here it should be borne in mind that the South African coals have a much lower moisture content than those of Europe, but are high in ash.

Since 1933 producers have had the opportunity of having their coal graded for sale on the inland market but with the ready demand for coal they have not considered it necessary to take advantage of the facilities.

Owing to the differing demands of the various consumers the marketable coal is classified according to size into rounds (with a diameter of more than 3½ in.), cobbles (1¼ or 1½–3½), nuts (¾–1¼ or 1½), peas (⅜–¾), and duff (less than ⅜).

Prior to the development of thermal electricity the demand for peas and duff was limited and large quantities were left on the tip heaps. Recently the position has been reversed and today the collieries have difficulties in meeting the needs of all the power stations. Because of this the Commission of Enquiry in Regard to Coal Shortages (1951) recommended that the size of pea coal should be increased to an upper limit of one inch square mesh.[7]

The Coal Reserves

The available coal reserves of South Africa are very large as may be gauged from the following table compiled from the information obtained by the Geological Survey up to 1948.[8, 9, 10]

Table 17. Estimated Coal Reserves of the Union of South Africa in 1948

Millions of Tons of 2,000 lb.			
Coalfield	*Actual*	*Probable*	*Total*
Transvaal			
Witbank	4,100	3,500	7,600
Springs-Heidelberg	8,200		8,200
Bethal		7,000	7,000
Middelburg, Belfast, and Eastern Witbank	1,000		1,000
Breyton, Ermelo, and Piet Retief	6,200	11,000	17,200
Springbok Flats		10,000	10,000
Waterberg	2,140	12,000	14,140
Soutpansberg		5,000	5,000
Vereeniging	184		184
Orange Free State			
Vereeniging	2,194		2,194
Vierfontein	181		181
Odendaalsrus		1,025	1,025
Natal			
Klip River	440	1,710	2,150
Vryheid	170		170
Utrecht	478		478
Union of South Africa excluding Cape Province	25,287	51,235	76,522

Of the proven reserves less than 160 million tons consist of straight coking coals and a little over 170 million tons of blend coking coals, while the potential reserves of each have been estimated at 33½ million tons and 93½ million tons respectively. Fears that the reserves will prove inadequate to support the sustained development of the iron and steel industry have been expressed in some quarters and the cessation of the export of Natal coking coals as steam coals advocated. The 1946–7 Coal Commission,[11] however, estimated that there are sufficient known reserves of both straight and blending coking coal to meet the requirements of the iron and steel industry for the next 55 years and that there are good prospects of discovering additional supplies, particularly in the Waterberg coalfield where a probable reserve *in situ* of over 500 million tons of coal, much of it with coking propensities, is indicated over the limited area so far surveyed. The known reserves of high-grade steam coal are very great, nearly 3,000 million tons occurring in the developed part of the Witbank–Middleburg coalfield alone, sufficient to meet the existing and prospective increased requirements for a period of well over 100 years; in addition there are large potential resources both in the as yet unexploited areas of the present mining concerns of the Transvaal and Natal and in new areas not yet fully prospected, particularly in the Breyton-Ermelo and Waterberg coalfields. Lastly there are enormous resources of medium and low-grade coals in the Transvaal and Orange Free State which so far have been scarcely touched. The actual and probable reserves of all grades of coal so far known are more than twice those of Great Britain, while further areas await prospecting. The known reserves per head of the White population, approximating to 100,000 tons, are the highest in the world, being far in excess of the nearest rival the United States, with a reserve of 38,000 tons per person.[1] The reserves per head of people of all races is 20,000 tons.

The Principal Coalfields

The following table indicates the relative importance of the main producing fields.

Table 18. Coal Output of the Main Producing Coalfields of the Union of South Africa, 1918–1953

Coalfield	*Output in Million Tons*			
	1918	*1938*	*1948*	*1953*
Witbank	3·7	8·1	12·2	13·7
Springs	0·6	0·8	0·7	2·1
Heidelberg-Balfour	0·2	1·7	2·6	2·1
Breyton-Ermelo	0·4	1·5	1·4	1·5
Klip River	1·7	2·1	2·1	2·5
Vryheid-Paulpietersburg	0·7	2·2	2·7	2·8
Utrecht	0·1	0·2	0·2	0·2
Vereeniging		1·5	2·8	4·1
Vierfontein				0·4

The remaining fields are not yet touched; they constitute large potential reserves for the future.

The Transvaal Coalfields

The Witbank Coalfield[1]

This is by far the most important coalfield in the Union, in 1953 contributing 44 per cent of the national coal output and 75 per cent of the coking coal. Its northern limit is coterminous with the abrupt edge of the Highveld plateau, beyond which the forces of erosion have removed most of the Karoo rocks, leaving only small outliers as detached portions of the field (Fig. 129). The eastern and western limits coincide respectively with the Wilge and Little Olifants river valleys from which the coal measures have likewise been removed by erosion and beyond which their character changes. The southern boundary is taken where a belt of igneous rocks either approaches or actually outcrops at the surface; coal measures extend southwards beyond this zone but the limited prospecting undertaken suggests that the coal seams change in character and value.

The relief of the coalfield is gently undulating with a gradual slope from the watershed along the Springs–Bethal railway where the elevation averages 5,500–5,600 feet northwards to the edge of the plateau, some 200 feet lower, but there is a sharp descent here to the Bushveld and likewise to the rivers which traverse the field. The thickness of the coal measures varies from 50 to 400 feet, increasing in a southerly direction, where the succession is more complete, but averages about 200 feet. The beds are horizontally disposed and the coal seams outcrop on the sides of the valleys, a feature which facilitated mining in the early days.

There are five distinct coal seams contained in a predominantly sandy series. They are usually underlain by sandstone and overlain by shale, the only exception being the uppermost seam which has a sandstone roof. Owing to the irregular surface on which the deposits were laid down the lowest or No. 1 seam is missing from some areas, particularly near the northern limit of the field, while erosion has removed seams 4 and 5 from the lower areas in the north. Towards the south however all the seams are preserved while an additional one at a slightly higher level has been identified in some boreholes. Generally speaking the seams are persistent over the whole area and show little variation in quality. The most important are the No. 1 or bottom seam, the No. 2 or main seam and the No. 5; the main seam is the one most extensively worked, while the No. 5 is increasing in importance with the southward movement of mining activities (Figs. 130–33). Generally speaking the bottom seam is the most valuable west of Witbank; to the east of which it becomes dirty. Here the No. 2 seam yields the best quality coal. The No. 1 seam varies in thickness from 4 to 10 feet and where reasonably thick is cheap and easy to mine, being free from faults or dykes of any magnitude. It yields a high-grade steam coal (calorific value 12·7–13·3 lb./lb.), with a low ash content (10 to 14 per cent), but is unsuitable for coke manufacture. The No. 2 or main seam lying some 7 feet above the bottom seam is the most extensive; it

averages 19 feet in thickness but near Witbank only the lower 4 to 15 feet are worked, the upper portion being high in ash content and much interbedded with shales. Three zones are recognized in the workable portion. The lowest zone, some 4 feet thick, consists of gas and blend coking coals high in volatile matter (35 to 40 per cent), low in moisture (1·5 per cent) and ash (5 to 10 per cent), and with calorific values exceeding 13·5 lb./lb. It is separated from an upper zone some 10 to 12 feet thick yielding bright steam coal (calorific value about 12·5 lb./lb., volatile matter 26 to 30 per cent and ash 11 to 15 per cent) by the 'holing' band comprising some 2½ feet of dull splint coal which is usually broken in holing and eliminated from the output. East of the Olifants river the upper shaly portion is missing and excellent coking and steam coals with calorific values exceeding 13·0 lb./lb. may be obtained from a thickness of up to 17 feet. The quality of the coal deteriorates in the extreme north and again in the neighbourhood of igneous felsites in the south. Generally speaking the coal of this seam is easy to mine but sometimes rolls[2] and 'wash-outs' interfere with smooth working. The former, caused by slight undulations which bring up the sandstone of the floor to a height of up to 7 feet, create difficulties for the coal cutting machines, while the latter, occurring in the shallow mines, and resulting from water percolation and rock decomposition along fissures in the roof, interfere with development and necessitate brick and concrete roof supports, timber rotting in the damp conditions after a short period of time. The No. 3 seam, separated from the main seam by about 30 feet of shale and sandstone, is everywhere too thin to be workable; while the

Fig. 129. The Southern Transvaal and Orange Free State coalfields.

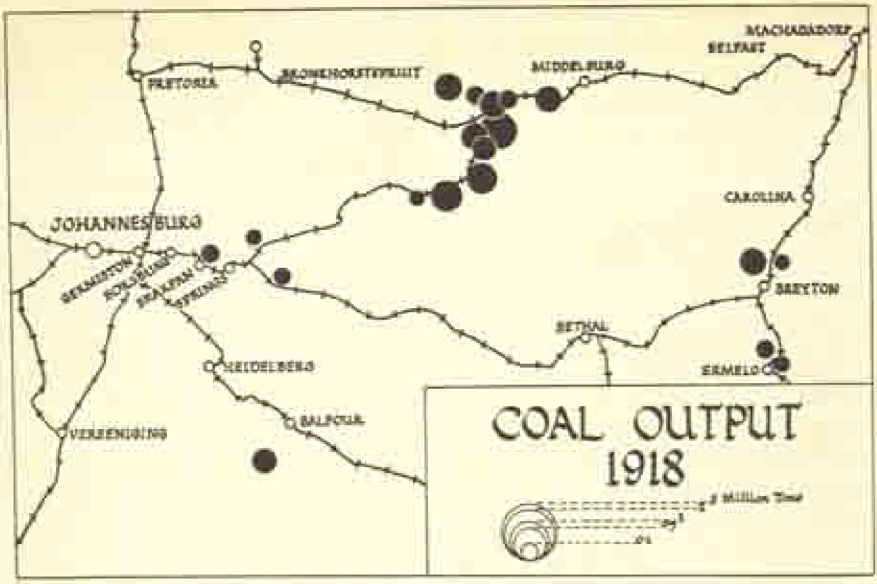


Fig. 130.

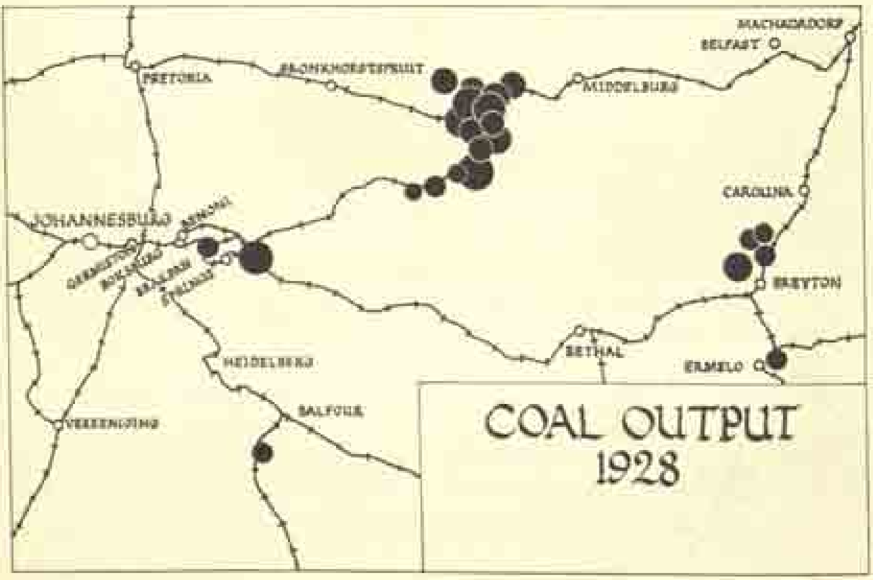


Fig. 131.

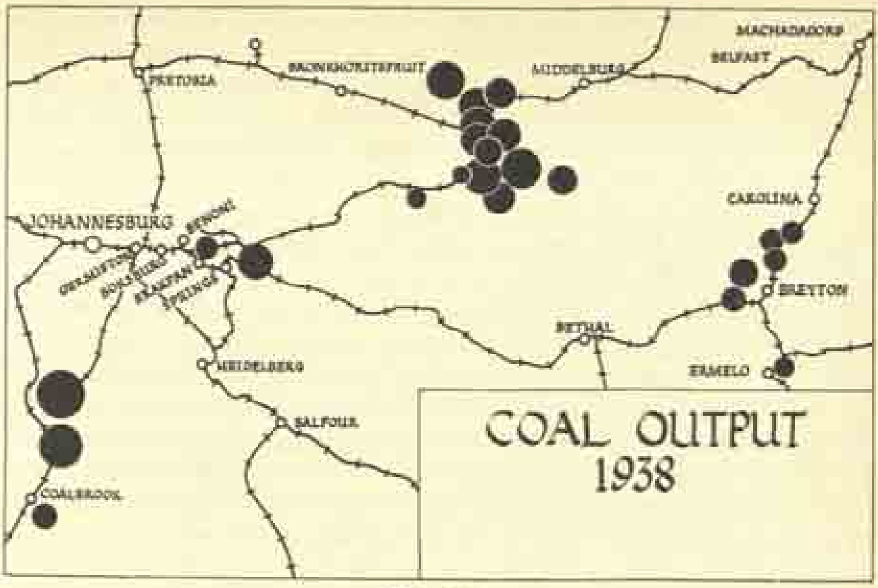
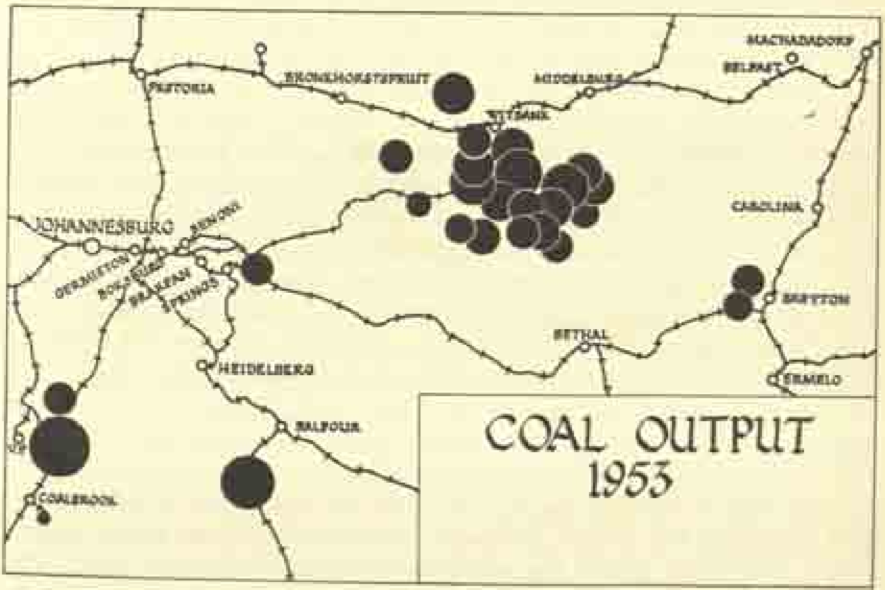


Fig. 132.



Figs. 130–133. The Southern Transvaal and Orange Free State coalfields.

Figures of coal production from the annual reports of the Transvaal and Orange Free State Chamber of Mines.

No. 4 seam, lying above a further few feet of sandstone in the west and up to 100 feet of sandstone and intrusive dolerite in the east, is generally of poor quality, and is mined only to a limited extent for the domestic market. The No. 5 seam, which lies between 30 feet and 120 feet above the No. 4 seam and is preserved mainly in the southern part of the coalfield, differs from the other seams in being contained between sandstones, free of shaly material and therefore clean. It is normally about 6 feet thick and yields gas and coking coals with a carbon content exceeding 80 per cent, a calorific value between 12·5 and 13 lb./lb., volatile matter content of 30 to 35 per cent, and ash content of 10 to 15 per cent. The quality of the coal improves east of the Olifants river, but the seam is thinner and has been denuded from a larger area; also intrusive sheets of dolerite which are absent from the rest of the field occur and have burnt some of the coal.

Commerical mining began in 1889 in the Brug and Steenkool spruits and on the detached outliers near Balmoral, in order to supply coal to the Witwatersrand gold mines. The field increased in importance with the completion of the railway line from Johannesburg to Lourenço Marques which opened the possibilities of an export coal trade and soon after the Anglo-Boer war new mines were opened along the railway between Witbank and Kendal. Production increased steadily, the entire output until about 1930 coming from the northern part of the field (Figs. 130 and 131). The production from most mines averaged between 50,000 and 500,000 tons per annum, the Witbank colliery with an output approaching 1 million tons being the only very large mine in the area. Most of the coal was sold for steam raising purposes on the railways and on the Rand while some was exported via Lourenço Marques. Attempts were made to produce coke but largely because European methods, involving a long coking time at moderate temperatures, were used, they proved unsuccessful. By 1933, however, methods of producing metallurgical coke from a blend of Witbank and Natal coal had been discovered and in 1934 the iron and steel works of ISCOR were set up in Pretoria. This had far-reaching effects on the coal mining activities in the Witbank coalfield, for the blend found most suitable for coke manufacturers required 75 per cent Witbank coal and only 25 per cent Natal coal. Moreover suitable coking coal could be obtained only by selective mining of No. 2 and No. 5 seams. This brought about a general increase in mining and a shift in the centre of activity in a southerly direction where the No. 2 and No. 5 seams, lying deeper, yield a better quality coking coal. Here large new mines were opened while some of the older small collieries along the northern outcrop closed down. Since 1940 the greatly increased home and export market has resulted in the acceleration of these trends. Between 1940 and 1952 seven large new collieries were opened in the southern part of the field and by 1952 there were six companies with an average annual output exceeding 1 million tons and three others approaching this figure. The trends towards a southward migration of activities and larger scale operations are continuing, and are being paralleled by the construction of branch railway lines from the main Johannesburg-Lourenço Marques line. At present two large

companies supply blend coking coal to ISCOR while the others produce steam coal for the home and the export market. For coking purposes coal from Nos. 2 and 5 seams are mixed in the ratio of 60 to 40 per cent crushed and washed at the mines and the resulting blend further mixed with 20 per cent Natal coal at the iron and steel works.

Generally speaking mining is easy and cheap. The seams are near the surface and most of the mines are so shallow – 50 to 300 feet – that the necessity for vertical shafts has not arisen; incline shafts are the rule (Plate 64) and the coal is raised to the surface either by endless rope haulage systems or on rubber conveyor belts. The thickness of the seams and their horizontal disposition favour mechanization and electric coal cutting machines have been in use since soon after the Anglo-Boer war. At first the pillar and stall method of extraction, whereby pillars of coal are left to support the roof, was adopted and where the depth of working did not exceed 100 feet it was safe to reduce the size of the pillars to as little as 7 feet by 7 feet at intervals of 20 feet before allowing the roof to collapse; only 5 per cent of extractable coal was lost by this method. In the deeper mines larger pillars became necessary and this prompted the introduction about 1920 of the retreating long wall method, which permits a greater overall extraction but necessitates the use of timber props for supporting the roof. At the present day the pillar and stall method is used in the shallower mines while the deeper ones favour the retreating long wall method. Generally speaking mining subsidence is not a problem for the horizontal disposition of the seams means that the surface is let down fairly evenly and in any case the mines are situated in open country free from urban development.

The Bethal Coalfield

This coalfield is separated from the Witbank field by the belt of felsite rocks; thence it extends southwards to the Vaal river; on the east and west it is bounded by the Little Olifants and Wilge rivers respectively. Relatively little is known about the field. Coal outcrops along the rivers and spruits in the north and in some places small adits have been opened to supply local demands but there are no large mines and prospecting has been discouraged by the lack of rail facilities in the more promising areas, the Springs–Breyton line following the watershed and traversing the area most disturbed by igneous intrusions. Further the records obtained from such boreholes as have been sunk are disappointing. The coal measures appear to occupy a basin-like area, developing their maximum thickness near Bethal. They are generally horizontally disposed but to the south of Standerton and Bethal they dip gently southwards and thin out at a depth of 500 to 700 feet from the surface. Three seams have been recognized, the A, B, and C. Of these seams B and C bear certain resemblances to seams 4 and 5 in the Witbank area but their correlation is uncertain and other features suggest that they accumulated in separate areas of deposition divided by the felsite ridge. The A seam has a discontinuous distribution, being confined to depressions in the

original floor level, is of poor quality and generally too thin to work. The B seam or main seam lying some 75 to 100 feet higher has an average thickness of 15 feet of which the lower 8 feet yield clean coal, but its calorific value is so low – averaging 10·5 lb./lb. – that it is not economic to work at present. The C seam is the best known; it is worked in adits from the valley outcrops. It lies about 30 feet above the main seam near the Wilge river but as much as 180 feet above it in the east. It yields coal suitable for household purposes but the interposition of a shale band 2 to 3 feet thick reduces the thickness of the clean coal making its economic working doubtful.

As far as is known the field is little disturbed by igneous intrusions except in the watershed region and would be relatively easy to exploit. In view of the low calorific value so far disclosed and the absence of rail facilities, however, the field is unlikely to be developed until the richer Witbank field has been worked out.

The East Rand Coalfields

These coalfields differ from those of Witbank and the eastern Highveld in a number of important respects. In the first place the Karoo rocks thin out towards Springs and Heidelberg and the coal measures have been preserved only in a series of depressions. In contrast to the area farther east, the coalfields occupy the lowest ground. Secondly the coal measures transgress older rocks and in many cases rest upon the Dolomite. While it is likely that they accumulated in separate areas of deposition near the margin of the coal measure swamps, their present distribution is due largely to subsidence into caverns produced by solution weathering in the Dolomite. In consequence the deposits have become tilted, deformed and sometimes faulted while the coal seams cannot be traced over any considerable distance. Mining is generally more difficult than in the eastern fields. Three separate coalfields are recognized.

The Springs Coalfield

To the west of the Blesbokspruit the coal measures are contained in at least two distinct basins at different levels, showing different successions of strata and different coal seams. Near Brakpan, where they overlie Dwyka conglomerate, they occur at a level some 350 feet higher than at Springs where they have subsided into the Dolomite. In the former area they are relatively thin but they thicken towards the south-east where a maximum of 200 feet is attained. The number and thickness of the coal seams increase in the same direction; near Brakpan there is only one seam with a workable thickness of 10 feet but to the south-east four seams, varying in thickness from 6 to 17 feet, are present. Except near Springs where the lowest seam yields coal with a calorific value exceeding 11 lb./lb., the coal is generally of poor quality, having a low calorific value (between 8 and 10 lb./lb.) and a high ash content. Ease of mining – the coal seams are practically horizontal and, apart from dislocations associated with subsidence near the rims of the basins, undisturbed – together with proximity to the Wit-

watersrand goldfields, however, led to the early exploitation of the field. Mining began on a small patch of coal at Boksburg which has long been worked out and abandoned. Later mines were opened north-west of Brakpan and south and south-east of Springs and yielded large quantities of coal before the railway connexion to Witbank was completed. In these early days the Springs coalfield played a very important role in the development of the goldfield. The completion of the Witbank railway hastened its decline. Much of the more accessible and better quality coal is exhausted and the remaining low-grade coal cannot compete with that of Witbank. All the collieries have now closed down, some of them being on fire when abandoned.

To the south of Springs small outliers of coal measures occur to the west of the Blesbokspruit and were formerly worked for local use near Nigel.

The Vischkuil–Delmas Area

The area between the Blesbokspruit and Wilge river affords the connecting link between the Springs and Witbank coalfields. The whole area is underlain by coal measures which overlie Dolomite west of Dryden and rocks of the Pretoria Series to the east. The coal measures are much intruded by thick dolerite sheets, particularly in the south near the Springs–Bethal railway. Here the coal is unaffected and only the difficulty of penetrating the overlying dolerite has deterred mining operations, but near Delmas the coal is anthracitic, a feature thought to be due to igneous intrusion at a lower level which may have destroyed some of the coal altogether. The coal measures increase in thickness from about 50 feet at Delmas to over 600 feet in the south-east where, however, nearly half the total consists of dolerite sheets. Three coal seams are present but only the lower 8 to 12 feet of the lowest seam has been worked yielding a coal of low calorific value (9·5 to 11·5 lb./lb.) and high ash content (22 per cent). There were formerly three collieries in the area while an unsuccessful attempt was made to open another near Delmas many years ago. At present there is only one colliery at work, producing coal for the Rand power stations at Brakpan, Rosherville, and Simmerpan and for one of the gold mines; and its output has fallen from around 800,000 tons in the early 1930's to 600,000 tons at the present day.

The Heidelberg–Balfour Coalfield

Between Heidelberg and the Vaal river there are several areas of productive coal measures of which that constituting the South Rand coalfield is the most important. Here the Dwyka conglomerate and the coal measures occupy a rectangular basin some 20 miles across cut into the Old Granite and Witwatersrand rocks, bounded on the west, north, and east by low ranges of hills and extending southwards at depth beyond the Vaal river. The coal measures have a total thickness of up to 700 feet. There are three coal seams, the uppermost of which is reached at a depth of about 470 feet and the main one nearly 80 feet lower. The upper beds are mainly sandstones but dolerite sheets are widespread and persistent, in places

attaining a thickness of over 340 feet. Fortunately, these have not affected the quality of the underlying coal. The two upper coal seams are too thin to be worked, but the lowest or main seam averages 25 feet, of which the lower 7 to 8 feet yield good steam coal similar to that of No. 2 seam in the Witbank area. This has a fixed carbon content exceeding 60 per cent, more than 20 per cent volatile matter and less than 15 per cent ash and a calorific value above 11 lb./lb. One colliery, producing an average of 150,000 tons annually, operated in this area until 1935 when it closed. The demand for coal at the power stations on the Klip river and along the Vaal, however, has led to renewed interest in the field and in 1950 a large new colliery capable of producing 2½ million tons of coal annually was opened near Grootvlei. This has been connected by railway to the Klip river power station to which it sends the greater part of its output, which by 1952 had already approached 2 million tons.

Limited patches of coal occur to the south of Heidelberg and were worked in a number of small collieries from the discovery of the Witwatersrand goldfields until soon after the turn of the century, when they were abandoned.

The Eastern Highveld Coalfields

These coalfields differ from those already discussed in a number of important respects. In the first place whereas in the Witbank and Springs fields the coal measures were laid down in basins, in the eastern Highveld they appear to have accumulated along a comparatively narrow belt of country sloping inwards towards a great depression centred over the present Basutoland and now concealed by a thick cover of younger Karoo rocks. Similar conditions of deposition are evident in Natal and possibly also on the other rim of the depression in the Orange Free State. The initial floor appears to have been uneven but the coal seams were not laid down until the irregularities had been smoothed out by the deposition of sand and mud. Thus, secondly, whereas in the Witbank field the coal seams occur near the base of the coal measures, in the eastern Highveld a great thickness of other strata intervenes. Between Breyton and Ermelo this is at least 200 to 300 feet thick while it increases to the south reaching 450 to 490 feet in northern Natal, where in addition the whole thickness of the Lower Ecca overlies the pre-Karoo floor. Thus in a northerly direction the Lower Ecca shales thin out and the coal measures rest on progressively older rocks. At the same time there is an overlap of the coal seams, which in the north-east occur at a much higher elevation than elsewhere. They vary greatly in thickness and character within short distances and hence their correlation in different areas is very difficult and often impossible. Broken country associated with complex igneous intrusions south of the Vaal river separates the Ermelo coalfield from that of Piet Retief-Wakkerstroom while changes in the character of the coal seams and in the aspect of the country at about the latitude of Carolina mark the transition to the Middleburg-Belfast coalfield.

The Ermelo Coalfield

The best known area of this coalfield is between Breyton and Ermelo where the normally featureless Highveld surface has been cut into by the headstreams of the Komati and Vaal, producing a series of ridges and valleys on the sides of which the coal seams outcrop. Commercial mining has been limited to the vicinity of the Breyton–Ermelo railway which follows the watershed between the Vaal and one of its tributaries. To the east open pits have been worked from time to time where coal occurs at the surface near Lake Chrissie.

The coal measures attain a thickness of 590 feet on the watershed north of Ermelo, but elsewhere little is known of their development. They consist essentially of sandstones and although thin shale bands, which in some cases are oil-bearing, are associated with the coal seams, they are less common than in the Witbank field. In the Breyton–Ermelo area there are five main coal seams of which only the three upper ones have been worked with the main output coming from the third or C seam. The A or top seam is usually too thin to work, but four miles south-east of Ermelo it thickens to 4 feet 8 inches and as a result of the proximity of a dolerite intrusion yields anthracitic coal which was mined for some years for local use. The B seam is generally of too low-grade to be worked but it is found over large areas and north and north-west of Ermelo is associated with an oil shale. The third or C seam is the most widely distributed seam and the one worked. In the Breyton area its thickness is 9 to 10 feet of which the lower 4 to 5 feet yield a good quality high-volatile coal with a calorific value averaging 12·45 lb./lb. This is suitable for domestic purposes and railway use. Its high volatile content commends it also for gas manufacture and for the production of oil. Oil shales are associated with it. Hitherto it has been worked only in a number of small collieries in proximity to the railway near Breyton and Ermelo, where it lies less than 20 feet from the surface, but prospecting indicates that there is an improvement in the thickness and quality of the seam with increasing depth to the west of the railway. Its exploitation in this area, however, depends on the provision of rail facilities and is unlikely while better quality coal is available in the Witbank field, particularly as much of the coal has been destroyed or rendered useless by intrusive dolerite dykes.

The Ermelo coalfield undoubtedly contains reserves of medium quality coal for future use. Moreover it is located in a well watered region near the edge of the Escarpment and with coal of high volatile content holds promise of exploitation for the production of oil from coal.

The Middelburg–Belfast Coalfield

This coalfield lies between the Little Olifants and Komati rivers. It has been much dissected by their headstreams and those of the Steelpoort river so that today it comprises irregular tongues and outliers of coal-bearing rocks. Very little is known of this coalfield. Two coal seams have been found in a number of shallow mines, which have been worked in the past for local use. Here the seams were

thick – 4 to 15 feet – and yielded good household coal, but the reserves are probably small.

The Piet Retief–Wakkerstroom Coalfield

This potentially coal-bearing area provides the connecting link between the coalfields discussed above and those of Natal. Whereas to the north the coal measures lie on the Highveld to the west of the Drakensberg, and in Natal emerge from beneath to outcrop over the eastern plateau slopes (see Fig. 134), between Piet Retief and Wakkerstroom they straddle both zones. Some of the coal seams actually outcrop along the Great Escarpment while the lower coal measures extend eastwards into the lower country. The latter usually rest on a floor of Old Granite or Primitive rocks but in the south the Lower Ecca shales intervene, marking the transition to the Natal sequence. The coal measures consist mainly of sandstones with thin beds of shale, sometimes oil-bearing, occurring in association with the coal seams. They attain a maximum thickness of 450 feet with the most important coal-bearing strata in the middle 150 to 170 feet. Here as many as eleven coal seams may be present but only four of them are persistent. Of these the second from the top, known as the Main Seam is most important. It varies in thickness from 4 feet 6 inches to as much as 14 feet and yields a high volatile bituminous coal with a calorific value exceeding 12·8 lb./lb. It has been tentatively correlated with the C seam of the Ermelo district and the Gus seam of Natal. In places the third seam is thick and of good quality but the top seam, consisting of high volatile coal suitable for oil production, and the bottom seam are too thin to work.

As yet this coalfield is untouched. It appears to contain large reserves of high quality coal for future use but owing to the effects of numerous igneous intrusions much of the coal and oil-shale has been rendered useless and the full potentialities of the field await further investigation.

The Natal Coalfields[1, 12, 13]

In Natal there are three main coalfields lying below the Great Escarpment and representing the surviving remnants of a once more extensive coal-bearing area which has been reduced by the progressive headward erosion of the east coast rivers. In the west the coal measures underlying the relatively level surface of the 4,200 feet erosion terrace form the Klip river coalfield; this is separated from the somewhat similar Utrecht field, occupying a broad promontory of the Highveld plateau 1,000 feet higher (Fig. 135), by the barren ground of the Buffalo river valley; in the east a number of detached mountain outliers in which the coal-bearing rocks have been protected from erosion by a capping of resistant dolerite make up the Vryheid–Paulpietersburg field (Fig. 136). Everywhere the coal measures have a very slight westerly dip towards the centre of the ancient basin of deposition. The seams outcrop at a progressively higher elevation towards the east (Fig. 134), but owing to the advanced stage of dissection, the widespread

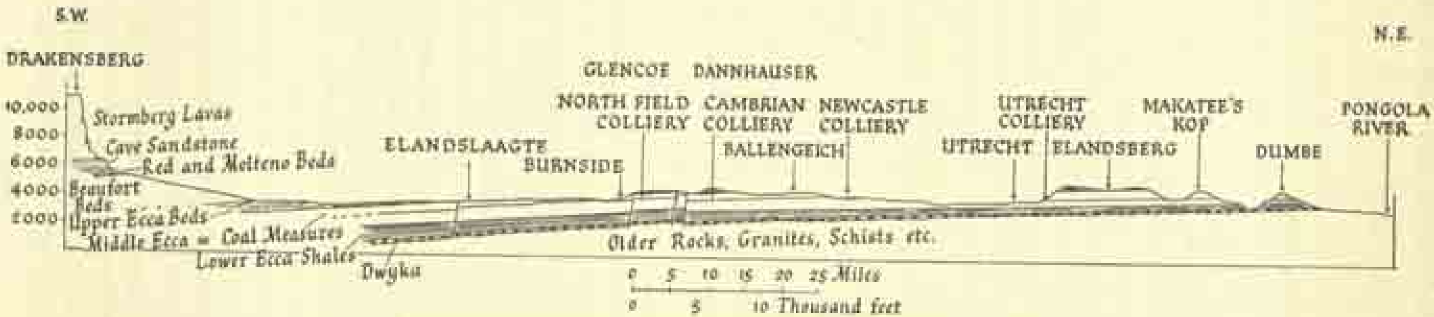


Fig. 134. Section across the Natal coalfields from south-west to north-east.

occurrence of dolerite sheets, which in extent, continuity, and regularity of thickness, are without parallel in any coalfield in the world, and the paucity of borehole information it is impossible to correlate them between the individual fields, which must therefore be considered separately. Besides causing mining difficulties, in many areas the dolerite intrusions have reduced the original bituminous coal to an unsaleable ultra-anthracitic type or even to graphite. It is estimated that at least 75 per cent and perhaps 90 per cent of the known coal areas are detrimentally affected in this way.[14] Despite this however, the three fields together contribute about one-fifth of the national coal output, furnish the only straight coking coals, and yield large quantities of high-grade steam and gas coal. Generally speaking all the coal is of high calorific value and its quality largely depends on its volatile content which is determined by the extent of igneous action. The course of mining has been greatly influenced by the pattern of railway development which has favoured the Klip river and Vryheid–Paulpietersburg fields at the expense of the Utrecht field.

The Klip River Coalfield

Here the coal measures underlie the relatively level surface and the coal seams outcrop only in the valleys. The series consists essentially of sandstones with which the coal seams are associated; the conglomerates and shales found in other fields are missing while a stratified ironstone is present at Prestwich. There are two workable seams which yield both coking and gas coal and are known as the 'Top' and 'Bottom'. Their thickness varies from 2 to 10 feet but is generally between 3 and 5 feet. In some places they are separated from one another only by a thin parting and can be worked together, but near Dundee some 40 to 55 feet of sandstone intervenes. Throughout the greater part of the area, however, the parting is between 5 and 6 feet, thereby hampering the extraction of coal from both seams and causing a certain amount of wastage.

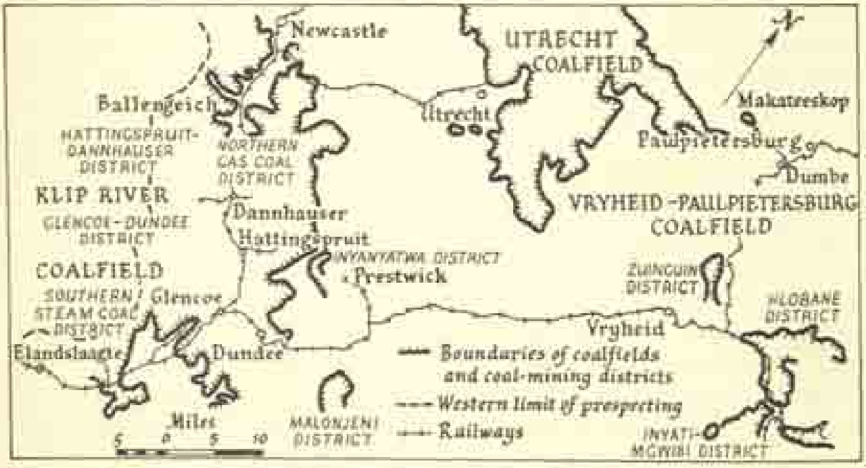
Within the field the course of mining development has been conditioned very largely by the ease of winning the coal, the availability of rail transport and the quality of the coal relative to the demands of the bunker, export, and coke markets. The first area to be developed was that lying to the south of the Impati fault.[15] Commercial mining began in 1889 when the railway reached Glencoe and a number of small collieries were opened near Elandslaagte where the coal seams, little affected by igneous action, outcrop near the railway. At the same time the Dundee Coal Company began to develop collieries on the coal outcrop south of Dundee and built a branch railway from Glencoe to serve them. This was completed in 1889 and in the same year the main line reached Newcastle. Mining, however, was confined to the southern area until after the South African war, for north of the Impati fault coal rarely outcrops in the vicinity of the railway and dolerite sheets are widespread, while around Newcastle the seams contain much shaley material and are generally unproductive. Operations were conducted on a comparatively large scale at Dundee (Fig. 137) where the Bottom seam averaging over 4 feet

thick yielded high-grade steam coal suitable for railways, bunker, and export. By contrast the Elandslaagte district was exploited by small workings, the seams were thin and highly faulted and, yielding only low volatile coal, soon ceased to be payable, so that many of the collieries closed down after only a few years of production.

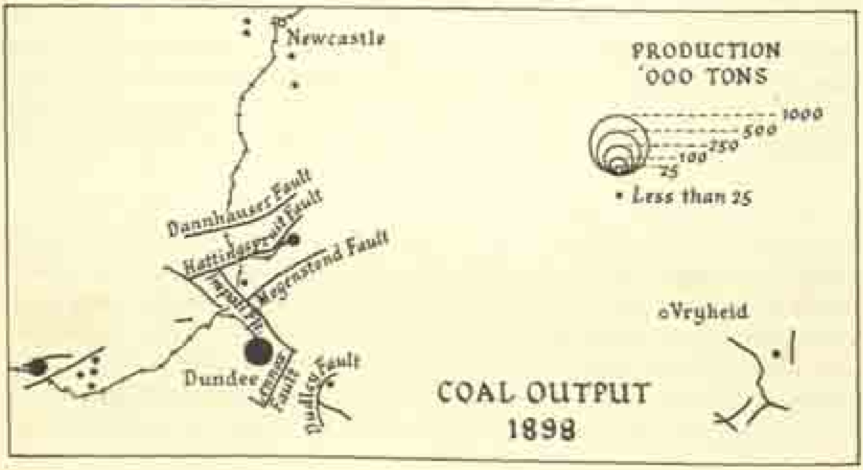
The period from 1903 to 1932 witnessed a northward shift in mining activities (Figs. 137–9), occasioned by the approaching exhaustion of the available reserves around Dundee, south of which the seams were thin and detrimentally affected by dolerite sheets and north of which they were burnt and badly faulted, and facilitated by a railway rating policy which substantially reduced the locational advantages of the southernmost mines. The siting of the new collieries was greatly influenced by the presence of major faults between Dundee and Dannhauser. Thus the main developments took place around Dannhauser, Hattingspruit and Glencoe, on the downthrow side of the major faults where the coal measures lie beneath great thicknesses of dolerite. The country between the Dannhauser and Hattingspruit faults where the strata had been upthrown to the extent of about 300 feet and the coal measures, including the most valuable coal seams, subsequently denuded over considerable areas, was naturally avoided. With the new developments came the change from open-cast to underground mining. Almost everywhere serious difficulties accompanied the sinking of shafts, particularly near Hattingspruit and Dannhauser where the coal seams are at greater depth than elsewhere (down to 750 feet compared with 500 feet at Glencoe). Sheets of hard dolerite up to 250 feet thick and occasionally as much as 400 feet thick, lying some 250 feet above the coal seams had to be penetrated so that progress was slow and sometimes halted by falls occasioned by the breaking away of columns of dolerite along vertical joints. Once the dolerite had been successfully penetrated the intersection of the coal seams revealed the presence of firedamp, resulting from the occlusion of the gases driven off by igneous action by the thick overlying strata. In some mines the newly-exposed coal faces gave off such quantities of gas that development was held up for nearly two years. The danger of explosions was accentuated by the high sulphur content of the upper seam making it liable to spontaneous combustion. Eventually following investigations by Government Commissions, regulations for the safe working of these fiery mines were framed but only after there had been considerable loss of life.

Further difficulties resulted from an acute labour shortage, for whereas the Transvaal coal mines received a preferential supply of Native labour in order to maintain the output of coal for the Rand gold mines, the Natal collieries were unable to obtain an adequate supply of Natives from Natal and Zululand or of indentured Indians and were forced to recruit less efficient workers from the Cape Colony. These difficulties hastened the introduction of mechanized coal-cutters in the larger mines but while these could be electrically driven in non-fiery mines, north and west of Glencoe, where firedamp was prevalent, only

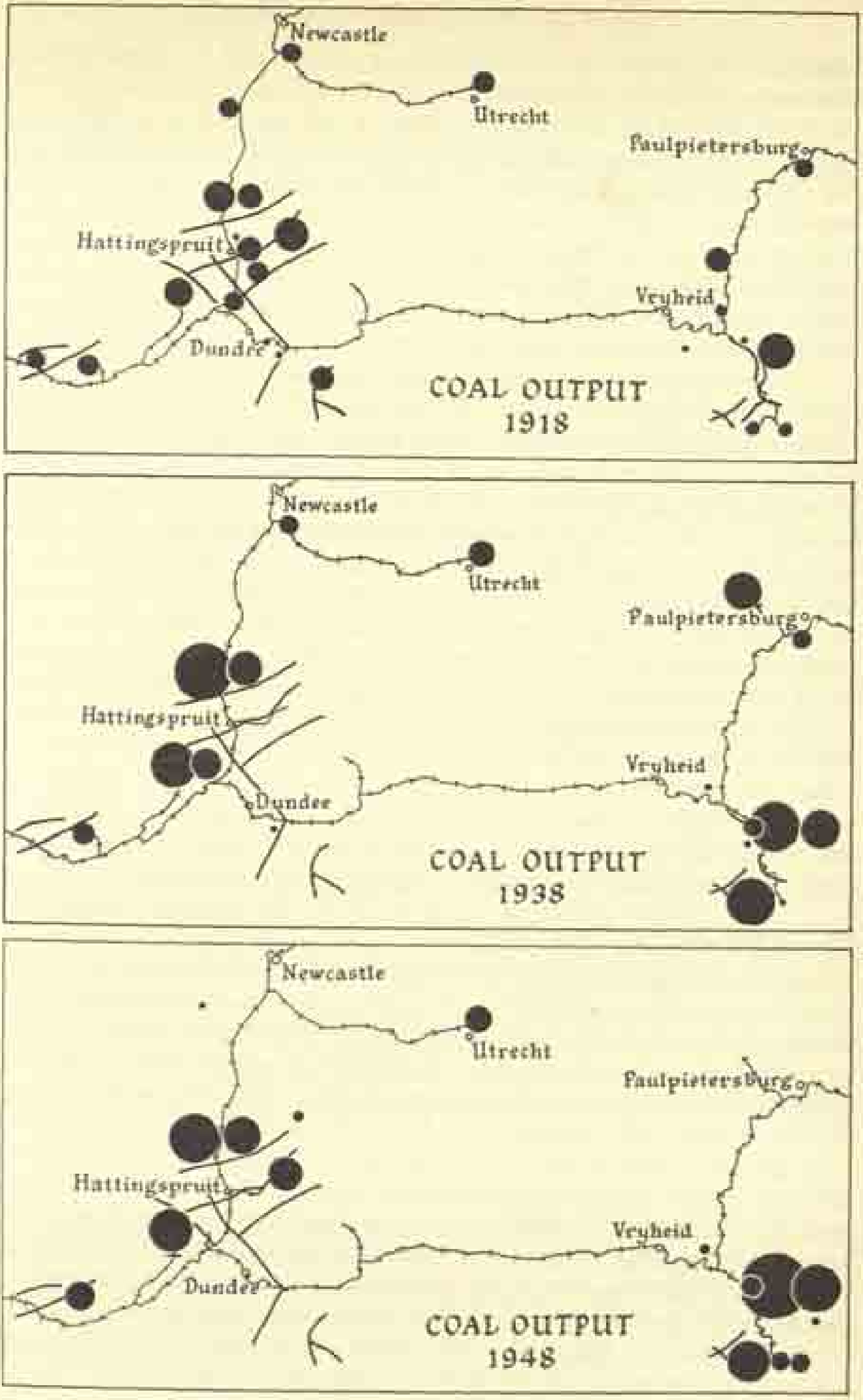
RELIEF
Feet
6000
5000
4000
Miles
5 0 5
BIGGARSBERG
Hennings
5046
Hlatikulu
5863
Inyanyatwa
5723
Impate
5218
Indumeni
5580
Malungeni
5742
Mauchline
5012
Sundays R.
Waschbank R.
Buffalo R.
Blood R.
Kandi
5017
Ngoja R.
ELANDS BERG
Makateeskop
5707
Dumbe
5042
KAMBULA MT.
ZUINGUIN MTS.
Zungeni
5615
HLOBANE MT.
INYATE MTS.
Nyatee
5373
MGWIBI MT.



Newcastle
UTRECHT COALFIELD
N
Ballengeich
Utrecht
Makateeskop
HATTINGSPRUIT-DANNHAUSER DISTRICT
NORTHERN GAS COAL DISTRICT
Paulpietersburg
Dumbe
KLIP RIVER
Dannhauser
VRYHEID-PAULPIETERSBURG COALFIELD
GLENCOE-DUNDEE DISTRICT
Hattingspruit
INYANYATWA DISTRICT
COALFIELD
Prestwick
ZUINGUIN DISTRICT
SOUTHERN STEAM COAL DISTRICT
Glencoe
HLOBANE DISTRICT
Vryheid
Elandslaagte
Dundee
Boundaries of coalfields and coal-mining districts
Western limit of prospecting
Railways
Miles
5 0 5 10
MALONJENI DISTRICT
INYATI-MGWIBI DISTRICT



Newcastle
PRODUCTION '000 TONS
1000
500
250
100
25
• Less than 25
Dannhauser Fault
Hattingspruit Fault
Mooigenoeg Fault
Impati Flt.
Vryheid
Dundee
Dudley Fault
COAL OUTPUT 1898



Figs. 135–40. The Northern Natal coalfields.

Figs. 135, 137–40 adapted from P. Scott, courtesy of the *South African Geographical Journal.*

compressed air could be used. Mechanization was followed by a great increase in output and at first marketing difficulties were experienced. Before the 1914–18 war the Natal collieries were unable to compete with Welsh steam coal in export markets or with the Transvaal coal in the inland market, and they had to rely very largely on the bunker and railway trade. With the establishment of iron and steel works at Benoni and Vereeniging in 1913, the demand for coking coal increased while after the war the reduced mining costs in Natal following the adoption of mechanized methods at a time when pithead prices in South Wales were steadily rising, enabled the South African producers to compete in other African, southern Asian, and South American markets.

Stimulated by the growing demand coal production expanded rapidly between 1918 and 1928 particularly in the Dannhauser and Hattingspruit areas, which produced high-grade coking, coking-gas and steam coals. By now the more accessible and productive areas of the Klip river field had been developed and while the output in the Dannhauser and Hattingspruit areas has continued to increase in order to meet the increasing needs of the iron and steel works established in Pretoria in 1934 and Vanderbijl Park in 1941, the output from the rest of the field has declined. Since 1933 the total output of the field has been eclipsed by that of the Vryheid–Paulpietersburg field. Substantial reserves of steam and coking coal, however, almost certainly occur in limited areas near Newcastle, where a new colliery came into production in 1949, west of the Durban Navigation Colliery at Dannhauser, south of Dundee and near Elandslaagte. In the last-mentioned area a new colliery[16] working both the top and bottom seams for coking and steam coal, was opened in 1950. When fully developed the colliery will produce between 300,000 and 400,000 tons of coal annually. Any great increase in output from the field is unlikely, however, owing to the growing appreciation of the need to conserve the limited coking coal reserves.

The Vryheid–Paulpietersburg Coalfield

The mining conditions in this field differ markedly from those in the Klip river field. Thus the coal measures are preserved only in a series of detached mountain masses – Zuinguin, Hlobane, Shongololo, Inyati, and Mgwibi east of Vryheid and Makateeskop and Dumbe near Paulpietersburg – rising some 1,000 feet above the level of the surrounding country; the coal seams outcrop from 500 to 700 feet up their sides. Development has been by adit and fiery conditions have rarely been encountered. The coal-bearing zone is thicker than in the Klip river field and contains five workable seams which vary in thickness and quality from place to place. In descending order these are known as the Alfred, Gus, Upper and Lower Dundas, and Coking seams. They have all been affected to differing degrees by the overlying dolerite, the upper seams suffering most. In consequence the best coal is obtained from the Coking Seam which, however, only attains a workable thickness at Makateeskop and Dumbe where it yields both coking and gas coal (used for many years by the Johannesburg Municipal gasworks) and in

northern Zuinguin. The Dundas seams also reach their maximum development in the northern areas where they yield good coking coal. On the other hand the Gus seam, the most persistent seam averaging more than 3 feet over the entire field, is most important in Hlobane, Shongololo, Zuinguin, and Mgwibi, where it has good coking propensities and in the last mentioned locality is suitable also for gas making. The Alfred seam is less important but yields steam coal in the Hlobane and Inyati areas. Generally speaking bituminous coals with a volatile content around 25 per cent are more numerous in the north while on account of igneous action, the proportion of anthracite increases in the south, particularly in Mgwibi. The development of this field, followed the arrival of the railway. The Zuinguin, Hlobane, and Dumbe deposits had been worked on a small scale as early as 1898 but their commercial exploitation dates from 1908 when the Glencoe–Dundee railway was carried as far as Vryheid, where the Dundee Coal Company had acquired mineral and surface rights on Zuinguin mountain. Later a branch line tapped the Hlobane district while in 1932 the Government extended the main line northwards through Paulpietersburg to Piet Retief. By 1918 Zuinguin and Hlobane had become important producing areas, Inyate and Mgwibi had started producing, and the coalfield as a whole contributed 28 per cent of the Natal output. Thereafter the relatively easy mining conditions, the existence of several workable seams in any one locality, the increasing demands for steam and coking coal at home and overseas and mineral legislation more favourable to prospecting and mining than in other parts of Natal (a legacy of the period when the Vryheid–Paulpietersburg area was not part of Natal) fostered rapid expansion. Progress was particularly rapid in Hlobane, Dumbe, and Inyati–Mgwibi. By 1926 the last-mentioned area, where output consisted of about 65 per cent steam coal, 20 per cent coking coal, and 15 per cent anthracite, had eclipsed Zuinguin which was approaching exhaustion. After 1932 the output of the Vryheid–Paulpietersburg field exceeded that of the Klip river field while production in the Hlobane area increased so rapidly that by 1938 it had become the leading area in Natal. In this year Hlobane and the Hattingspruit–Dannhauser area of the Klip river field together accounted for more than half the Natal output. Their importance increased further with the exhaustion of the Makateeskop and Dumbe deposits and the inability of the northern and southern parts of the Klip river field to furnish high-grade steam and coking coal required for bunkering, export, and the iron and steel industry during the war and post-war years. By 1948 the Vryheid–Paulpietersburg field contributed 54 per cent of the Natal output of five million tons, the Hlobane area alone accounting for 41 per cent and the Inyati–Mgwibi area 12 per cent (see Fig. 140). The reserves of the Vryheid–Paulpietersburg coalfield, however, are limited and rapidly dwindling and it seems likely that the centre of coal mining activity in Natal will shift back to the Klip river field where the less accessible areas await development and ultimately to the Utrecht field.

The Utrecht Coalfield

The Utrecht coalfield which in the north is contiguous with the Piet Retief–Wakkerstroom field of the Transvaal constitutes the largest coal-bearing area in Natal but owing to its distance from railways remains undeveloped. The line from Vryheid to Piet Retief passes well to the east while the Newcastle–Utrecht line merely touches its western edge. In the east the principal seams of the Vryheid field have been identified and promise to yield high-grade coking and steam coal. They are present also at Utrecht where, however, only the Gus seam is workable, the others being of low grade. Here the Gus seam yields a high-grade volatile coal, with a low ash content, but owing to its tendency to clinker it can be used only as domestic fuel. In the central parts of the field shaft sinking will be complicated by the presence of extensive dolerite sheets – one borehole north-east of Utrecht passed through 453 feet of dolerite – and dykes, while much of the coal, which varies from bituminous to semi-bituminous, has been burnt. Nevertheless an extensive drilling programme has been started north of Utrecht in the hope of finding coking coal.

The Orange Free State Coalfields

With the exception of the Vredefort dome and areas of ancient rock along the Vaal river below Vereeniging, the greater part of the Orange Free State is underlain by Karoo rocks. The coal measures outcrop in the north and coal-bearing strata probably underlie some 10,000 square miles. They dip gently to the south-east where they are overlain by increasing thicknesses of younger Karoo rocks. In the north their total thickness, where not removed by denudation, is from 400 to 500 feet and they contain from one to four coal seams with an aggregate thickness of from 6 to 53 feet. They generally rest on a thin bed of Dwyka conglomerate which overlies the Dolomite. Near the junction of the Vaal and Wilge rivers they have been intruded by a great sheet of dolerite varying in thickness from 150 to 412 feet and lying from 150 to 400 feet above the coal seams. This extends in a south-westerly direction towards Heilbron, frequently outcropping at the surface. It is absent from the vicinity of Vereeniging but a similar sheet, 77 feet thick, is encountered in the Clydesdale Colliery, 14 miles to the south. These intrusions appear not to have affected the quality of the coal which, however, is generally poor, but they hamper mining activities. To date the only areas exploited are around Vereeniging and near Vierfontein. Between these two areas little is known of the geology.

The Vereeniging Coalfield

The development of this coalfield is due to the presence of a nearby market and has taken place in spite of low-grade coal and difficult mining conditions. There are two coal seams, the lower averaging about 10 feet and the upper between 15 and 24 feet, separated by 8 to 11 feet of conglomerate and sandy shales and overlain by from 40 to 100 feet of shale and 50 to 60 feet of sand which carries

much water and has the character of a quicksand. Only coal from the bottom 8 feet of the lower seam is worked, that from the upper seam being of too poor quality. Even that from the lower seam is low-grade, containing only 50 per cent fixed carbon, having a moisture content exceeding 5 per cent and an average calorific value of 10·7 lb./lb. The percentage of volatile matter is relatively high (25–30 per cent), however, and the ash content low (15–20 per cent) and the coal is quite good for steam-raising purposes.

The first attempts at opening the field south of Vereeniging were made towards the end of the last century in the hope of supplying the Witwatersrand market, but mining difficulties caused their failure. In this area the coal measures have subsided into deep sinkholes in the Dolomite. The quicksand made shaft sinking difficult and dangerous while the inflow of large quantities of water at seam level from the surrounding dolomite caused the abandonment of the first shaft. Similar difficulties were experienced with a second shaft. Prior to 1912 little development took place. In that year the Vereeniging power station, designed to utilize low-grade coal, was commissioned and after 1916, with the use of the Francois cementation process by which shafts could be sealed from water-bearing strata, development went ahead and production increased rapidly. The opening of further power stations on the Klip river and along the Vaal hastened progress until today the field contains the largest collieries in the country, the output of the Cornelia colliery exceeding 3 million tons annually. The thickness of the seams permits a high degree of mechanization, but near Vereeniging the unfavourable grades near the rim of the sinkholes – where over short distances the seams may be tilted at 70° – hampers the development of haulage systems while the inflow of water from the Dolomite necessitates pumping. Today development is proceeding farther south where more nearly horizontal seams and easier mining conditions compensate for lower grade coal. The coal area to the north of Vereeniging is now approaching exhaustion and already the Klip river power station (Plate 65), draws its coal from a new mine south of Balfour.

The vast reserves of low-grade coal, high in volatile matter and low in ash, with plentiful water at hand and ready access to the largest consumer market in the country has prompted the establishment of an oil-from-coal industry near Coalbrook (Plate 66). This is a Government project, in terms of the Liquid Fuel and Oil Act of 1947 (regulating and controlling the manufacture of liquid fuel and oil from coal), backed by loans from the International Reserve Bank and the Import-Export Bank of America. The establishment which bears the name SASOL is the largest of its kind in the world with an annual production of 55 million gallons of petrol and 16 million gallons of other products including diesel and lubricating oil, ammonia, tar and organic solvents. The daily output of over 100 million cubic feet of purified gas is fed into a grid system for the supply of the Reef towns. In order to meet the annual requirements of 2¼ million tons of coal a new colliery has been opened nearby. Since the output of petrol meets only one-sixth of the present consumption of the country additional plants may be

expected if this first project is successful. The proven coal reserves at the colliery are sufficient to last for 150 years and the reserves in the vicinity are thought to be inexhaustible. Expansion may, however, be limited by inadequacy of water supplies. The existing plant uses between 7 and 10 million gallons daily and already the resources of the Vaal are almost fully utilized.

The Vierfontein Coalfield

Little is known about this coalfield in which three collieries have operated in the past but have had to close owing to lack of demand for low-grade coal. Their output was used mainly for steam-raising purposes on the Kimberley diamond mines with whose vicissitudes their fortunes fluctuated. The position, however, has now changed with the development of the Free State and Klerksdorp goldfields and the erection of a large new power station at Vierfontein. To supply them a new colliery has been opened, coming into production in 1952. Only one coal seam is present. This occurs at a depth of 70 feet from the surface, is enclosed between sandstones, and has an average thickness of 7 feet 6 inches, all of which is worked. Mining is, therefore, easy and cheap, but since the coal has a calorific value of only 9 to 10·5 lb./lb. its market is limited. Little is known of the reserves, but it is thought that the coal measures thin out towards Bothaville, but that they extend over a considerable distance to the south-east of Vierfontein, where at increasing depths the quality of the coal improves.

Other Coalfields

Of the remaining coal-bearing areas those of the Waterberg and Soutpansberg districts of the Transvaal are most promising. In the former coal seams varying in number from ten to twenty and in thickness from 2 to 30 feet have been proved in a shallow basin, faulted against the Waterberg sandstone in the south and extending northwards to the Limpopo. The coal horizon occurs at a depth of from 100 to 1,600 feet below the surface. The succession resembles that of the Wankie coalfield of Southern Rhodesia with workable seams in both the Upper and Middle Ecca Series. Small quantities of straight coking coal which must be washed twice in order to eliminate its high ash content, have been proved in the former series, which is thought to contain also large quantities of blend coking coal. The Middle Ecca seams are expected to yield large quantities of steam coal, comparable with that of Witbank. The reserves are considered to be enormous but their development depends on the provision of a railway while difficulties are likely to be experienced from the water-bearing overlying sandstone. In the Soutpansberg district coal occurs in a number of detached areas south and south-east of Messina, where it has been used by the Messina Copper Co. for smelting and general purposes. It lies only 50 feet below the surface, is of coking quality, and relatively near the existing railway but its ash content is high and the reserves are limited. Further south coal seams of considerable thickness have been encountered in boreholes in beds of Middle to Upper Ecca age underlying

the Springbok Flats, but the quality is very inferior and as the area is far removed from large consuming centres, exploitation is unlikely in the near future. In the eastern Transvaal and Swaziland coal measures occur in the low country west of the Lebombo range, where they underlie a belt some six miles wide and several hundred miles from north to south. In some places good quality coal may occur but owing to the proximity of the overlying mass of the Lebombo lavas, much of the coal is anthracitic and of only limited use.

In Natal renewed interest has recently been shown in the Somkele coalfield, west of the St Lucia. Coal, probably of Ecca age, was discovered here some time before 1894 but mining did not take place until after the extension of the Durban-Verulam railway to Somkele in 1902. The Zululand Colliery began operations in the following year, but the poor quality of the coal, which was described as anthracitic and dirty, and lack of markets forced its closure in 1909.[17] Further prospecting ceased after 1902 when much of the ground was withdrawn from private prospectors by the Natal Government which contemplated opening a State mine in the area. There was renewed interest in the field between 1936 and 1939 when the Umfolosi Co-operative Sugar Planters Ltd investigated the possibility of using local coal in their sugar refinery near Mtubatuba. The old workings being flooded, proposals were made for a new colliery, but following disappointing borehole results, the project was abandoned in 1941. Interest, however, was again revived in 1949 when new claims were pegged over the old workings. Whereas in the east proximity to igneous rocks causes much of the coal to be anthracitic and burnt, it is anticipated that bituminous and semi-bituminous coal may be found further west, where hopes are entertained of an oil-from-coal project for which the Umfolosi river would provide unlimited quantities of water.

In the Cape Province coal occurs in the Stormberg series of the Karoo System but it is of very inferior quality, being high in ash and low in volatile matter.

Methods of Mining

Coalmining in South Africa has benefited greatly from the late exploitation of the fields and the application of techniques evolved on the Witwatersrand gold mines and in the great coal mining nations of the world, notably the United States. Although the coal was dug in a number of localities in early times the modern development of the industry has not been hampered by old workings. From the first the mines were laid out as large highly mechanized units, features made possible by the disposition and thickness of the seams, and the availability of electric power and necessitated by the shortage of labour. Except in the Orange Free State water has not been a problem, the mines on the whole being remarkably dry, while fiery conditions have been encountered only in the Klip river field of Natal. In most cases overlying sandstone has afforded a relatively safe roof and accidents have been less frequent than in the coalfields of Europe.

In the Transvaal and Orange Free State, where the seams are at relatively

shallow depths, access is by means of inclined shafts, in most cases not more than 200 feet from the surface; in Natal adit mining is practised in the Vryheid–Paulpietersburg field but in the parts of the Klip river field where the seams are at depths exceeding 500 feet, vertical shafts are necessary. In most mines the coal is hauled to the surface in mine tubs through inclines over easy gradients by endless rope haulage systems but in some of the Transvaal mines conveyor belts are used. In the Vryheid–Paulpietersburg field the coal moves from the mouth of the adit down the mountain slopes by gravity haulage systems.

Most mines are worked by the pillar-and-stall method by which pillars of unworked coal are left to support the roof, the size of the pillars varying with depth from the surface. In the shallow mines this did not lead to a great wastage of coal. A primary extraction of 67 to 80 per cent was usually followed by a secondary extraction in which the size of the pillars was reduced and the roof eventually allowed to collapse. By this means 85 to 90 per cent of the coal was recovered. But with deeper mining larger pillars had to be left and considerable losses of coal resulted. In the Transvaal some of the deeper mines, well located to receive pit props from the timber plantations along the Escarpment, have adopted the retreating longwall system whereby all the coal is removed, the roof being temporarily supported by pit props and then allowed to collapse gradually as the coal is worked out. Some of the Natal collieries have followed suit while the new Platberg colliery near Newcastle is designed to be worked by a combination of both methods, the primary extraction being by pillar-and-stall and the secondary by retreating longwall.

Electrically operated mechanical coal cutters were introduced in the Transvaal mines soon after the Anglo-Boer war. Today 98 per cent of the coal of the province is machine cut. The proportion – 96 per cent – is only slightly less in the Orange Free State where some difficulties are experienced as a result of subsidence into the Dolomite. Even in Natal where the seams are thinner and the fiery nature of many of the mines restricts the motive power to that of compressed air, 74 per cent of the coal was machine cut in 1945, when the figure for the mines of Great Britain was 72 per cent.

The high degree of mechanization makes possible a high output per man. In 1950 the average for the Union was 522·8 tons which may be compared with 310·3 tons in Great Britain. In the Transvaal the average was 660·5 tons and in the Orange Free State 726·9 tons, in both cases showing an improvement over the 1935 figures which were 628·4 tons and 682·2 tons respectively. In Natal, however, the output had fallen from 327·7 tons in 1935 to 267·1 tons in 1950, but the low figure for the latter year is partly associated with the approaching exhaustion of the older mines and the fact that the newer ones were still in the development stage.

The high output per man combined with the low wages paid to Native miners – in 1950 in the Transvaal and Natal 76*s.* and 70*s.* per month respectively with quarters, food, and medical attendance – results in a low pithead price for

coal. In 1950 this averaged 7*s.* 4*d.* per ton for the Union on a whole, ranging from 6*s.* 6*d.* in the Orange Free State to 12*s.* 6*d.* in Natal, which is far below that of most other producers – 17*s.* per ton in Australia, 34*s.* per ton in the U.S.A., 45*s.* per ton in Great Britain and 65*s.* per ton in Belgium. The lower wage bill is largely responsible for the differences. Thus whereas in 1950 wages amounted to 29*s.* 8*d.* per ton of saleable coal in Great Britain, in the Union the corresponding figure was 3*s.* 3*d.*, but the difference in the balance indicates a greater overall efficiency, on the South African mines.

The Changing Markets for South African Coal

The following table reflects the changing relative importance of the chief markets for South African coal.

Table 19. The Chief Markets for South African Coal, 1918–53

User	Percentage of Total Output			
	1918	1928	1938	1950
Gold Mines	25·0	15·8	12·0	7·7
Railways	23·0	24·4	24·0	18·9
Bunker	13·0	12·4	6·9	1·7
Export	12·2	12·3	6·5	9·5
Coke Ovens	0·6	1·9	3·8	7·0
Electricity Works			28·0	29·9
Cement Works				2·0

Coal mining began in order to meet the fuel requirements of the gold mines and the railways while subsequently a small bunker and export trade developed. Until the close of the first world war the gold mines and the railways took about one-half of the output. At that time abnormal conditions in the main exporting countries gave South Africa an opportunity for a larger share of the export trade. Coal production increased rapidly but export was hampered by congestion on the railways, which was only partially relieved by the electrification of the single line track between Glencoe, where all the Natal coal traffic converges, and Pietermaritzburg, after 1921. Moreover, coal grading had not then been adopted and during the boom period South African coal got a bad name through the export of inferior grades. In consequence with the return of peacetime conditions South Africa was unable to compete in overseas markets, despite the introduction of coal grading in 1922. After 1930 significant market changes developed. The demands of the gold mines remained static while those of the railways increased with the general economic development of the country. The establishment of the Government iron and steel works at Pretoria in 1934 created a new market for coking coal while the wartime development of new works at Vanderbijl Park and the subsequent expansion of both led to such increased demands for coking coal that by 1950, 7 per cent of the total output was used for this purpose. Most

spectacular, however, has been the greatly increased consumption for electricity generation associated with the building of new power stations along the Vaal river. In 1950 nearly 30 per cent of the total output was used for the purpose, a figure which may be compared with the 16·5 per cent of the amount retained for home use, used for this purpose in Great Britain. The amount consumed in the gasworks remains very small. In 1955 the coming into operation of the SASOL oil-from-coal project near Coalbrook brought a new use for South African coal. With petrol and oil as its principal products and gas as an important by-product this new market promises to consume increasing quantities of the total coal output in future. Meanwhile the bunker trade has dwindled to practically nothing with the change to oil-burning ships while the export trade has suffered a relative decline. The export trade revived during the second world war and in 1945, when over 4 million tons of coal were exported, South Africa temporarily became the world's leading exporter. Since then, however, overseas sales have declined owing to increased home demands, an acute wagon shortage on the railways and inadequate shipping facilities. Indeed after 1945 recurrent coal shortages were experienced culminating in actual crises during the severe winter of 1951 when the partial closing of the cement and brick and tile industries became necessary and some of the power stations were down to a day's supply. During this period the difficulties were increased by the discrepancies between the controlled price for coal on the home market, virtually frozen at the 1938 level, and the higher prices obtaining overseas. In 1950, for example, although only 7½ per cent of the total Transvaal output was exported, more than half the profits of the collieries came from this source. Because of this the collieries endeavoured to keep up their overseas trade in face of a shortage on the home market, with the result that eventually the railways were forced to intercept coal on the way to the ports, for their own use. Eventually in 1951 a Commission was appointed to investigate the shortages. Its findings indicated that congestion on the railways was primarily responsible for the difficulties and that shortages were largely confined to certain grades of coal, particularly peas, the consumption of which had increased immensely with the increase in electricity generation and the growth of the cement and brick and tile industries. Because of the wagon shortage many of the larger Transvaal collieries were only working to 70 per cent of their capacity. Congestion at the ports caused delays in the turn round of wagons. In order to overcome the difficulties recommendations were made for improving the handling facilities at the existing ports, particularly Lourenço Marques, which now ships more coal than Durban, the creation of a new port on Sordwana Bay to provide an additional outlet both for the Transvaal and Northern Natal fields, the development of a coastwise shipping trade to relieve the strain on the railways and an increase in the wagon and locomotive capacity of the latter. Here it may be mentioned that in 1950 an agreement was made to send 1½ million tons annually to Pakistan, the Union's best customer, through Lourenço Marques but the shipping and port handling facilities are inadequate for its execution. Meanwhile

the needs of the home market, and particularly of the essential services such as the railways and power stations are paramount. In this connexion the more universal washing of coal – a process made difficult in some areas because of inadequate water supplies – more efficient screening, the installation of crushing machinery to step up the production of pea coal and bring the output more into line with the demand, the use of greater quantities of duff by the power stations is necessary. As in so many branches of South Africa's economic life, the coal industry today faces difficulties caused largely by over-rapid expansion and failure to adjust production to changing market demands.

At present between 70 and 80 per cent of the Transvaal output is marketed through the Transvaal Coal Owners Association, which was formed in 1907 in order to reduce the ruinous competition prevailing amongst coal producers at that time. The bulk of the requirements of the railways, gold mines, electricity undertakings and industrial users is supplied by the Association under long-term contract; the non-associated collieries cater mainly for the domestic market. In Natal the inland trade is largely controlled by the Natal Associated Collieries, and the bunker trade by the Natal Coal Owners Association, both of which were formed in 1930 because of acute competition between producers during a period of uncertain markets. Since 1925 all the coke produced in Natal has been marketed through a co-operative selling agency known as Coke Producers Ltd.

Coke

Since South Africa possesses only very small quantities of gas coal, the gas-making industry is undeveloped. In consequence domestic coke – a by-product of gas making, is produced only in negligible quantities from the gasworks of Johannesburg, Cape Town, Port Elizabeth, and Grahamstown. There is in any case very little demand for it. Metallurgical coke, produced by coke ovens, is used mainly in the iron and steel industry, with the growth of which the output is closely linked.

Prior to 1913, coke production was limited to small quantities required by the assay offices of the Rand Gold Mines. With the establishment of iron and steel works at Benoni in 1911 and Vereeniging in 1913, the demand increased and some of the Natal collieries erected coke ovens. With the exception of the installation at Waschbank, all were of the beehive type, the coal being too poor in volatile matter for by-products to be economically recoverable. Even today the only by-products ovens are those at Waschbank and the Vryheid Coronation colliery, whereas three other coke producing companies maintain beehive ovens. Until 1934, coke making was confined to the Natal coalfields where the only straight-coking coals are found. An unsuccessful attempt to produce coke from Transvaal coal was made as early as 1890,[18] when primitive beehive ovens were erected some 20 miles south-south-east of Witbank. Further attempts followed in 1910 when coal was taken to Middlesbrough in England for coking, but largely because the coking time was too long and the temperature too high, only inferior

coke was produced. During and after the first world war, experiments using retorts and beehive ovens, were conducted at Pretoria; these indicated that intimate mixing and rapid heat penetration were essential. Further test, undertaken by the German iron and steel concern, Gutehoffnungshutte, and the Transvaal Coal Owners Association followed. These established that satisfactory metallurgical coke could be produced by blending washed coal from the numbers 2 and 5 seams of the Witbank field with a suitable proportion of Natal coking coal. This prepared the way for the establishment of a large iron and steel industry in the country. At first 25 per cent Natal coal was blended with 75 per cent of Transvaal coal derived from the No. 2 seam, but with improved methods of coke manufacture the proportion of Witbank coal rose to 97·5 per cent by 1941. With the subsequent increasing use of coal from No. 5 seam, however, the proportion has fallen to 80 per cent.

Since 1934 the annual output of metallurgical coke has kept pace with the development of the iron and steel industry reaching nearly 1¼ million tons in 1950. About two-thirds of this comes from the coke ovens of the integrated iron and steel works (ch. 25, p. 414), and the remainder from plant installed at the collieries. The pithead coking plants are found only in Natal for the necessity of blending the Transvaal coals makes coke production at the iron and steel works a more economic proposition. All the Transvaal coke is used at the iron and steel works, while that of Natal finds wider markets in the explosive factories at Modderfontein (near Johannesburg) and Somerset West, the carbide factories at Witbank and Ballengeich as well as in the Natal and Transvaal iron and steel plants. Four of the five Natal coke producing plants are on the Vryheid coalfield and except for Vryheid Coronation, where modern carbonizing plant has recently been installed, consist of open burning beehive ovens, numbering nearly 800. The Waschbank plant, however, consists of 56 by-product recovery ovens which supply ammonia to the Umbogintwini fertilizer factory on the Natal south coast for sulphuric acid manufacture and to the Somerset West explosives factory for nitric acid production. At the Pretoria works of Iscor the coking plant consists of two batteries totalling 102 ovens with a daily capacity of 1,400 tons of coke. A by-products works produces concentrated ammonia liquor, naphthalene, benzole, tar, etc., while the 'waste' gases are cleaned and cooled for use in firing the furnaces.

BIBLIOGRAPHY

1. W. J. WYBERGH. *The Coal Resources of the Union of South Africa.* Vol. I, The Coalfields of Witbank, Springs and Heidelberg and of the Orange Free State, 1922; Vol. II, The Inland Coalfields of Natal, 1925; Vol. III, The Coalfields of the Eastern and South-eastern Transvaal, Springbok Flats, Waterberg, Zoutpansberg, and of the Cape Province, 1928. Geol. Surv., Mem. No. 19, Govt Printer, Pretoria.

2. J. MCPHEE. 'Coal in the Transvaal'. *Emp. Min. Met. Cong.*, Pt 3, S.A. Mining. 1930.
3. E. A. STEART. 'Coal in Natal'. *Emp. Min. Met. Cong.*, Pt 3, S.A. Mining. 1930.
4. H. B. S. COOKE. 'The ancient geography of South Africa'. *S.A.G.J.*, Vol. XXXII, 1950, p. 11.
5. *The Mineral Resources of the Union of South Africa.* Union Dept of Mines, Govt Printer, Pretoria, 1940, p. 360.
6. Ibid., p. 377.
7. Union of South Africa. *Report of the Gold Commission* 1946–7. U.G. No. 29, 1948, p. 82.
8. A. L. NOACH. 'South African coal reserves'. *S.A. Min. Eng. J.*, Vol. LX, 1950.
9. *Union of South Africa, Yearbook*, No. 26, 1950.
10. See also F. A. VENTER. 'Coal in the Union of South Africa', Pres. Address Geol. Soc. S.A. *Pr. G.S.S.A.*, Vol. LV, 1952, pp. xxix–lvii.
11. Union of South Africa. *Report of the Commission of Enquiry in regard to Coal Shortages (1951)*. U.G. No. 9, 1952, p. 39.
12. J. J. G. BLIGNAUT, F. J. J. FURTER, and J. C. VOGEL. *The Northern Natal Coalfields (Area No. 1). The Vryheid–Paulpietersburg Area.* Dept of Mines Coal Survey, Mem. No. 1, Govt Printer, Pretoria, 1940.
13. J. J. G. BLIGNAUT. 'Coal provinces in the Natal coalfields'. *T.G.S.S.A.*, Vol. LIV, 1951.
14. W. T. HESLOP. 'The Natal coalfields'. *J. Chem. Met. S.S.A.*, Vol. XVII, 1916–17, p. 184.
15. PETER SCOTT. 'The development of the Northern Natal Coalfields'. *S.A.G.J.*, Vol. XXVIII, 1951, p. 57.
16. W. R. GORDON. 'The Newcastle Platberg Colliery'. *S.A. Min. Eng. J.*, Mar. 1950, p. 3.
17. 'The Somkele Coalfield, Natal,' Dept of Mines, *Industrial Minerals*, Quarterly Review, April to June 1950, p. 19.
18. P. E. HALL. 'Recent investigations of the coking of Transvaal coals and blends'. *J. Chem. Met. Min. Soc. S.A.*, Vol. XXXIII, 1932–3, p. 258.

Power Resources and Manufacturing Industries

23

Power

The Generation and Supply of Electricity

South Africa possesses great power potentials. Owing to the erratic flow of her major rivers and the general absence of falls of great magnitude, there are few opportunities for the development of hydro-electricity but with enormous resources of easily won coal, she enjoys exceptional advantages for the generation of thermal electricity and as one of the world's leading producers of uranium, the opportunities for the development of atomic power are very great.

The Growth of Electricity Production

The development of the power resources of South Africa, like so many other things, dates from the opening of the Witwatersrand gold mines. At first steam power derived from coal was used to hoist the ore to the surface and to move the ore crushing machinery, but as mining became deeper and the scale of activities increased electrical power became necessary. At the same time the provision of electricity for lighting the growing towns became important. To meet these needs the first electricity undertakings financed by private companies and the larger municipalities were formed.

Before 1923 the only electricity undertaking of any size was that of the Victoria Falls and Transvaal Power Co. formed in 1906 to cater for the Witwatersrand gold mines. Its main generating stations were located on the Witwatersrand, i.e. near the load centre, at Brakpan, Simmerpan (Germiston), and Rosherville (Johannesburg), and along the Vaal river at Vereeniging. Their combined capacity was only 180 MW. The larger municipalities owned stations of less than 10 MW capacity.

After the first world war the need for increased mechanization on the gold mines (see ch. 19, p. 303), for the electrification of the railways over the Escarpment (see ch. 32, p. 486) and for the development of industry to absorb the 'Poor White' population (see ch. 24, p. 393) led to the passing of the Electricity Act in 1922. This set up an Electricity Control Board (four years before similar steps

were taken in Great Britain) and provided for the establishment of an Electricity Supply Commission as a Government electricity undertaking working on a non-profit making basis. The latter came into being in 1923 and at once took steps to increase and co-ordinate the production and supply of electricity in the main demand centres. The development of large-scale power projects and of long distance transmission of electricity began.

The Railway Administration was already building a power station at Colenso to serve its proposed Glencoe–Pietermaritzburg electrification; arrangements were made for the transfer of this station, on its completion, to the Commission, and for the establishment of a Natal undertaking. This took place in 1927. Meanwhile in 1924 agreements were made with the municipalities of Cape Town and Durban and with the Railways whereby the Commission undertook to erect power stations and supply bulk electricity. The Cape Town and Durban Undertakings were then established. At the same time the Victoria Falls Power Company agreed to build and operate a new station at Witbank for the Commission in order to furnish additional power for the gold mines, provide for the electrification of the Reef railway and supply the town of Witbank. The Witbank Undertaking was then formed. Subsequently the Klip and Vaal stations near Vereeniging were built under similar agreements. Finally in 1948 the Commission purchased the Victoria Falls Company and formed the Rand Undertaking. Meanwhile in 1947 the East London municipal station was acquired and the Border Undertaking set up; a year later the small stations at Kingwilliamstown and Alice were taken over. In 1949 the Cape Town Undertaking, which had embraced the Caledon and Worcester stations in 1939 and 1940 respectively, became the Cape Western Undertaking and in 1950 the de Beers Company station at Kimberley was acquired as the nucleus of the Cape Northern Undertaking. On the enlargement of their supply areas in 1955 the Rand and Witbank Undertakings became the Rand and Orange Free State, and the Eastern Transvaal Undertakings respectively. The Durban Undertaking was renamed the Natal Southern Undertaking. Thus the Electricity Supply Commission has extended its influence and provided for the electricity needs of the country. Today it owns over 70 per cent of the generating capacity of the country and distributes power over 117,000 square miles, 25 per cent of the country. The large municipalities of Johannesburg, Cape Town, Pretoria, Port Elizabeth, and Bloemfontein account for the major portion of the remaining capacity and the Commission has agreements with the first three mentioned for the pooling of output at peak periods. Today all the more closely settled parts of the country receive electricity (Fig. 143). As yet there is no national grid. Each undertaking operates as a unit but the power stations of the Rand and Eastern Transvaal undertakings form one generation pool and those of the Natal Central and Natal Southern undertakings a second. A third pool comprises the Salt river stations of the Commission and the Table Bay and Dock Road stations of the Cape Town City Council.

Since 1923 there has been an enormous increase in the electricity generating

capacity of the country (Fig. 141). During the middle 1930's two large new power stations were built in the southern Transvaal and existing stations already supplying the Rand extended in order to meet the growing needs of the Witwatersrand gold mines. At the same time the Commission's stations at Cape Town and Durban were enlarged and new municipal stations built at Johannesburg, Pretoria, and Cape Town to supply the expanding domestic market. The second world war halted progress but since 1945 the installation of new generating plant

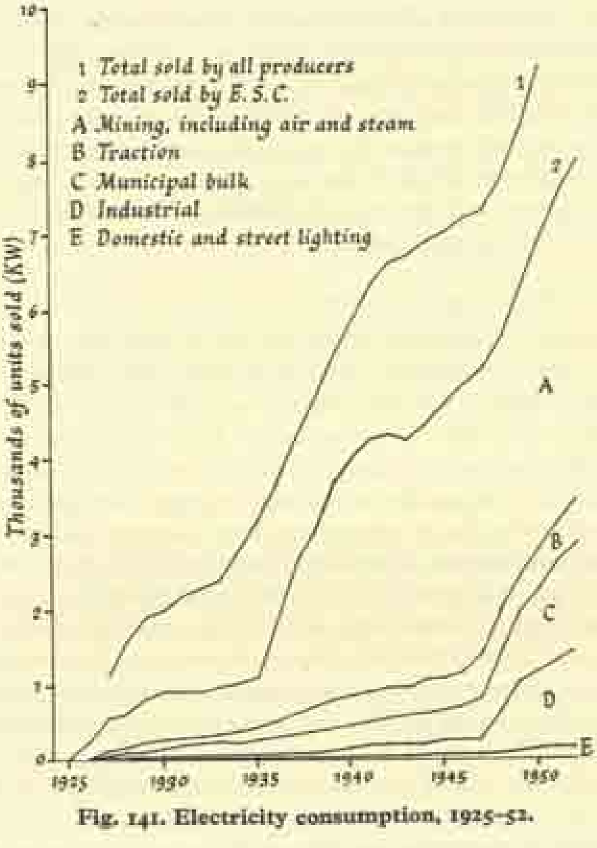


Fig. 141. Electricity consumption, 1925–52.

both at new and existing stations has taken place on an unprecedented scale in response to the demands of the new Orange Free State and Klerksdorp gold mines and of the many new industries that have arisen in the southern Transvaal, in the major ports and on the coalfields. By 1954 the total installed capacity of the Commission's stations was 2,652 MW and that of the municipal stations of Johannesburg, Pretoria, Cape Town, Port Elizabeth, and Bloemfontein 780 MW, the former representing a 235 per cent increase and the latter a 100 per cent increase over the 1945 capacity. In addition generating plant totalling 930 MW

was on order or being installed at the Commission's stations and the installation of a further 600 MW planned; the municipalities of Johannesburg, Pretoria, and Cape Town had plans for new stations.

The growth of electricity generation has been marked by a tendency to build increasingly larger stations and to transmit power at higher voltages over greater distances. Twenty years ago the largest station, at Vereeniging, had a capacity of only 140 MW. Today the Klip river station (Plate 65) north of Vereeniging has an installed capacity of 424 MW making it the largest in the southern hemisphere, while the new Taaibos and Highveld stations being constructed south of Vereeniging will each have a capacity of 480 MW. In the newer stations, by the use of larger boilers and generators, considerable improvements in efficiency have been achieved. The new Hex river station near Worcester, for example, has a thermal efficiency of 24 per cent whereas that of the old Simmerpan station completed in 1910 is only 10 per cent. While, however, increased efficiency reduces the cost of electricity generation, it is to some extent offset by the more exacting locational requirements of the larger stations.

The Location of the Generating Stations

With the exception of the Sabie station and one or two other very small hydro-electric plants on the eastward flowing rivers and small diesel electric stations supplying small towns, all the power stations are steam driven. Their location has been governed by proximity to the load centre, availability of cheap coal, supplies of cooling water, and ample space for cooling towers, railway sidings, coal handling plant, coal storage dumps and ash disposal. With the large-scale bulk transmission of power at high voltages over long distances, the first mentioned is less important than formerly but wholesale transfer over thousands of miles is not yet feasible. The second and third are of increasing importance.

Low-grade coal is suitable; the cost of its transport may exceed its pithead price and usually exceeds the cost of electricity transmission over the same distance. In 1954 for example whereas the average price per ton of coal delivered at the pithead Vaal station was only 6*s.* 10*d.* it was 15*s.* 6*d.* at Rosherville (Johannesburg), 27*s.* 2*d.* at Congella (Durban), 29*s.* 1*d.* at Kimberley, and 41*s.* at Salt River (Cape Town). Transport even over short distances is expensive; for instance the cost of coal at the Klip station has doubled since the exhaustion of the adjacent colliery has necessitated bringing supplies from its new pit at Grootvlei, 41 miles distant. When it is remembered that in 1954 the cost of coal at all undertakings represented nearly one-third of their operating costs the importance of cheap supplies is apparent. Moreover, large quantities are needed. The Klip station alone consumes between 2¼ and 2½ million tons per year. For thermal power stations a location on or near a large coalfield is clearly most favourable.

Power stations use enormous quantities of cooling water to condense the steam which has passed through the generators. The water condensed is returned to the boilers for re-heating. While the amount required varies with the atmos-

pheric temperature and humidity, even in the newest stations, e.g. Vierfontein along the Vaal, under South African conditions, 3 million gallons of cooling water are required hourly for every 60 MW of generating plant in operation in order to replace water lost by evaporation and by blow-down, and keep the circulating water within the limits of hardness and purity. This is 50 per cent more than the amount required in Great Britain, where the temperatures are lower and the relative humidity higher. Direct cooling is possible at stations adjacent to the coast, major rivers, and large bodies of inland water, but elsewhere cooling towers must be erected. In fact the general shortage of water and the many demands on existing supplies make cooling towers essential at most stations. The Klip river station (Plate 65) for example has ten cooling towers each with a capacity of 2 million gallons per hour. In the municipal stations of Johannesburg, Pretoria, Cape Town, and Bloemfontein shortages of cooling water are being overcome by the use of sewage effluent. Even at the coast difficulties are experienced. For example at Cape Town the risk of stormy seas during south-easters and north-westers precludes abstraction from the open seas, supplies being drawn from the Duncan Dock.

Large power stations require plenty of space. Cheap land of low rateable value is essential. This is generally available but some difficulties are being experienced in siting new municipal stations.

The Main Power Areas

Today the large power stations are concentrated particularly (1) along the Vaal river, (2) on the Witwatersrand, (3) on the Witbank coalfield, (4) in the municipal areas of Johannesburg, Cape Town, and Durban with single large stations in the other major towns and at Colenso and Worcester along the trunk railways (Fig. 142). The major concentration of developed and projected generating capacity is in the first-mentioned area, where the advantages of a coalfield location, plentiful cooling water from the Vaal river, proximity to the Witwatersrand, Klerksdorp, and Free State gold mines and plenty of cheap land are combined. A colliery has been developed in conjunction with each power station and the coal is delivered direct to the furnaces. Thus electricity is very cheaply produced, enabling the Rand Undertaking to accord rates per unit sold of between 0·33*d*. for mining concerns and 1·12*d*. for domestic users. The stations on the Witbank coalfield enjoy similar advantages of cheap fuel and plentiful water – drawn from the Olifants and Wilge rivers – while the stations are well placed to serve the traction requirements of the Reef railway. In addition they supply the coal mines, and industrial and domestic consumers in the vicinity and on the Rand (Fig. 143). Today the Witwatersrand stations comprising the early stations of the Victoria Falls Company are at a disadvantage. Originally their location was determined by the proximity to the consumer and their site, adjacent to natural pans, by the need for cooling water. Limitations in the supply of the latter precluded their expansion while the increased cost of fuel occasioned by distance

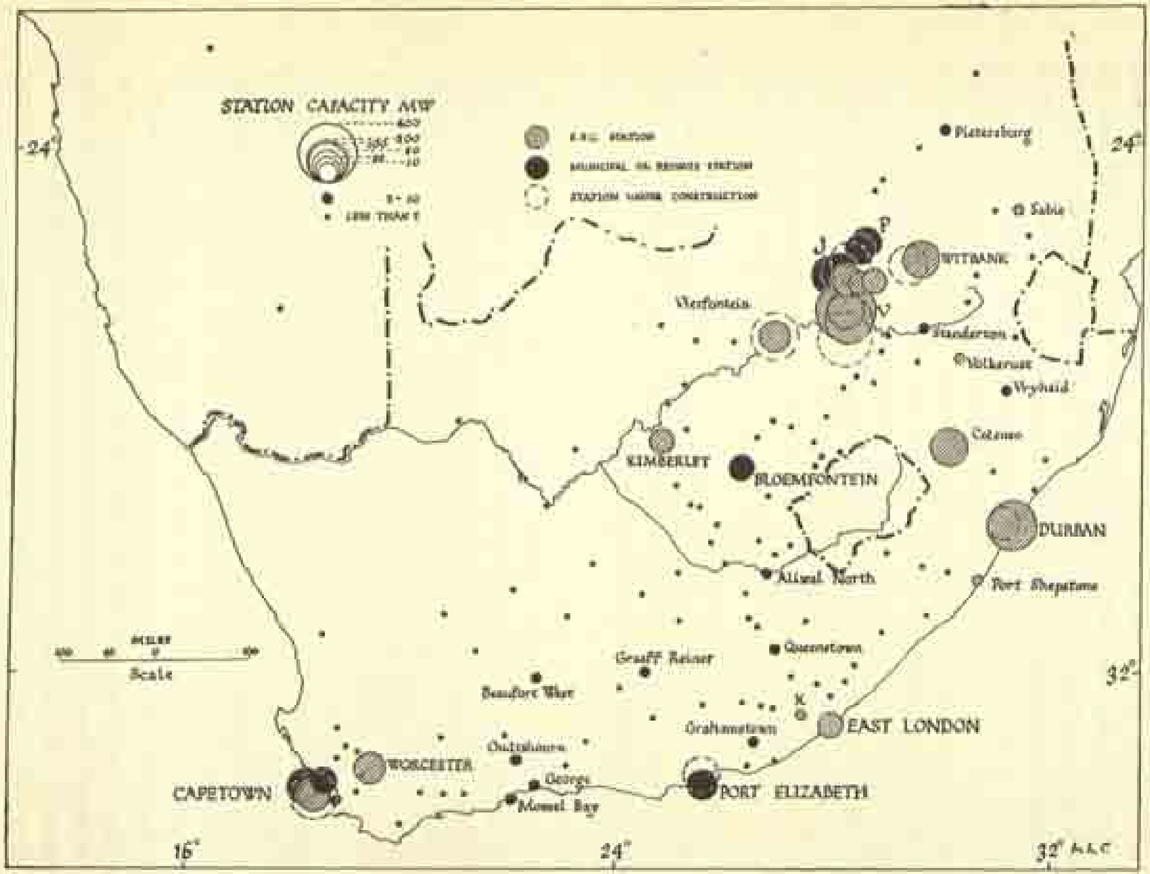


Fig. 142. The distribution and capacity of the electricity generating stations in the Union of South Africa, 1953.

(Compiled from statistics given in the 31st Annual Report of the Electricity Supply Commission of South Africa, Johannesburg 1954, and from information obtained from the individual municipalities.)

from the coalfield reacted against them when long distance transmission of current became possible. The *raison d'être* of the city generating stations is the market. Domestic and industrial consumers take the bulk of the output of the municipal stations while the railways take a large share of the electricity generated at the Commission's Salt river (Cape Town) and Congella (Durban) stations. The early stations were located in the heart of the cities on sites where rail facilities and cooling water were available. In fact the City Generating Station in

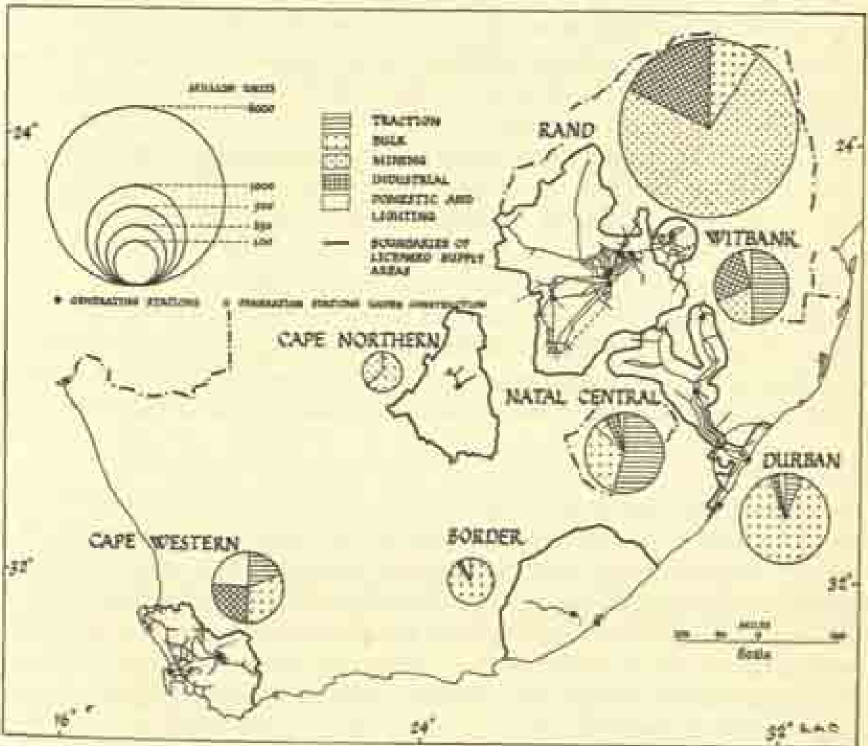


Fig. 143. Electricity transmission and sales by the Electricity Supply Commission of South Africa in 1953.

Johannesburg supplied power over a network not exceeding one mile in radius. These stations soon reached the capacity of their sites and as the demand increased new stations were erected outside the main built-up area. In 1942 Johannesburg built a station of 150 MW capacity at Orlando, fifteen miles south-west of the city centre while such has been the increased demand resulting from industrial and residential growth since 1945 that a new station is planned at a similar distance to the north-east. Similar developments have necessitated a new station in the growing industrial area on the north-eastern outskirts of Cape Town, while Pretoria plans a new station some fifteen miles beyond her city

centre. In order to provide for the increasing needs of the Durban area the Electricity Supply Commission is building a new station near Pinetown, fifteen miles from the centre of Durban, while it built the first stage of a new station at Zwartkops, seven miles north of the city centre of Port Elizabeth, and then sold it to that municipality.

Parallel with the development of generating capacity the transmission system has been extended in each of the undertakings of the Electricity Supply Commission. In addition to the gold mines, large municipalities and railways, most of the smaller towns within their supply area are served, as well as isolated collieries and factories in Natal, the Transvaal, and Orange Free State. The Rand Undertaking now supplies power to the Thabazimbi iron mines, the Rustenburg platinum mines, and the Rooiberg tin mine. The more closely settled agricultural areas are supplied by farm schemes, particularly the fruit-growing districts of the south-western Cape where electricity is required in the packsheds, for pressing grapes and also for pumping irrigation water. The new Hex river station at Worcester, designed mainly to provide for the electrification of the railway to Touws river has made possible farm schemes in the Breede river valley as far eastwards as Swellendam. Transmission lines from Cape Town serve the fish canneries near Saldanha Bay. In the less closely settled rural areas, the demand is too small to warrant the expense of transmission over long distances and small diesel electric plants catering for individual requirements are more economical.

The Future

While, compared with other countries, South Africa is favoured by her ability to produce cheap thermal electricity, production costs vary considerably within the country. Due to distance from coalfields and consequent high price of coal, the cost of electricity generation in Cape Town, Port Elizabeth, East London, and Kimberley is more than twice that in the Rand Undertaking. Because of this and because the country is a large producer of uranium the erection of atomic power stations is being considered with Cape Town, where coal is most expensive, as the likely site for the first one.

BIBLIOGRAPHY

The information contained in this chapter has been obtained from the annual reports of the Electricity Commission and from direct contact with the larger municipalities.

24

The Emergence of South Africa as an Industrial Nation

The Growth of Industry

Until the Great Depression of 1929–32 South Africa was essentially a primary producer depending on exports of gold, diamonds, wool, and maize with which to pay for manufactured goods of all kinds. Agriculture, mining, and commerce provided employment for most of the people and although some industries had been established manufacturing was relatively unimportant. The realization that industrial development was essential in order to provide employment for the 'Poor White' population, had, however, led to the enactment of far-reaching measures between 1918 and 1928 – the establishment of an Electricity Supply Commission in 1922, the creation of a Government-sponsored Iron and Steel Corporation (ISCOR) in 1928, provisions for training South African youth in skilled occupations and for the regulation of factory working conditions between 1918 and 1925 and the introduction of a new customs tariff imposing heavy duties on imported manufactured goods in 1924. The onset of the Great Depression brought a temporary setback to industrial development, but the abandonment of the gold standard inaugurated a period of expansion in gold-mining which in turn stimulated industrial enterprise. At the same time the low world prices for agricultural commodities severely hit the farming community and increasing numbers of people sought employment in the towns.

During the late 1930's many industries were established so that at the outbreak of war in 1939 South Africa was already emerging as an industrial nation, although mining still dominated her economic life. During the war she was cut off from overseas supplies of manufactured goods and under the protection thereby afforded rapidly developed a variety of industries utilizing her own raw materials (see Fig. 144). After 1945 the general world shortage and consequent high price of many manufactured and semi-manufactured goods, especially steel and machinery, at a time when new goldfields were being developed, ensured the continued expansion of existing industries. At the same time the prospects of spacious sites,

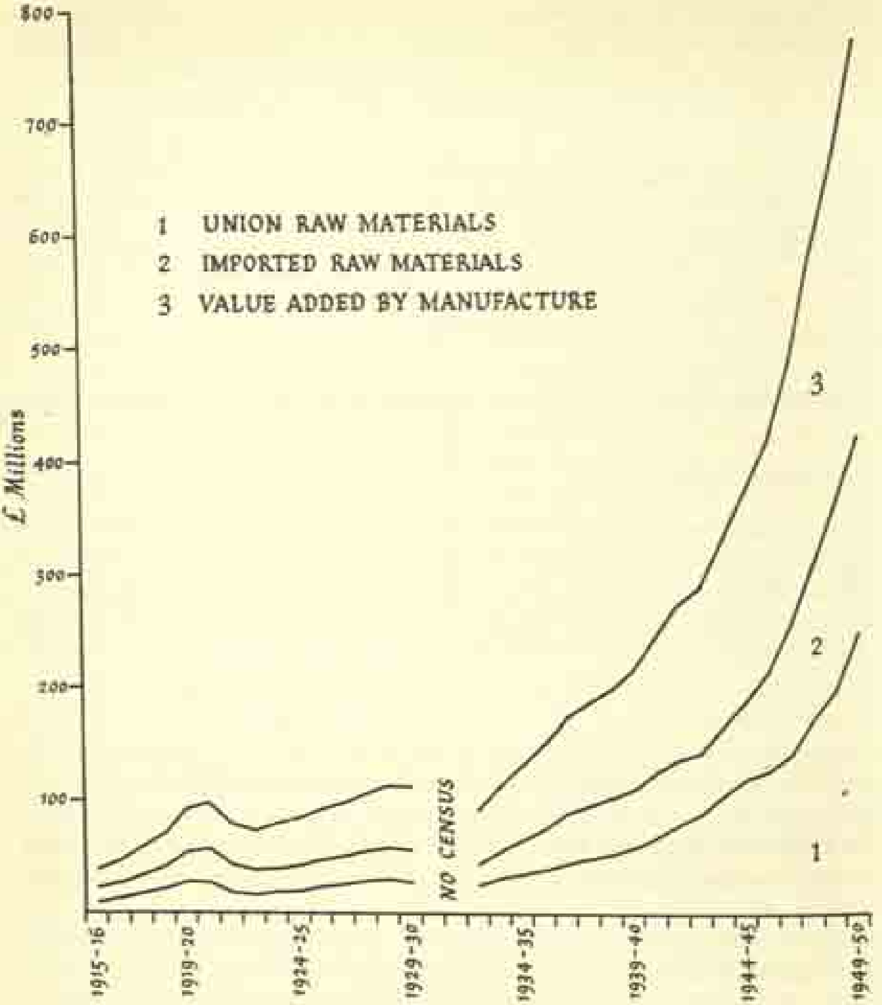


Fig. 144. The growth of manufacturing industry in the Union of South Africa; the value of output, of raw materials used and of amount added by manufacture, 1915–50.

(Compiled from statistics given in the annual censuses of Industrial Establishments.)

developing power resources, cheap labour and perhaps most important, access to expanding markets both in the Union and in Central Africa, attracted many newcomers. Such was the rate of development that between 1938–9 and 1950–1 the number of Europeans employed in manufacturing industries increased from under 145,000[1] to over 252,000[2], while the number of Non-Europeans so employed rose from about 207,000 to nearly 527,000 (Fig. 145). Indeed by 1950–1 manufacturing concerns provided work for nearly 50 per cent more workers than

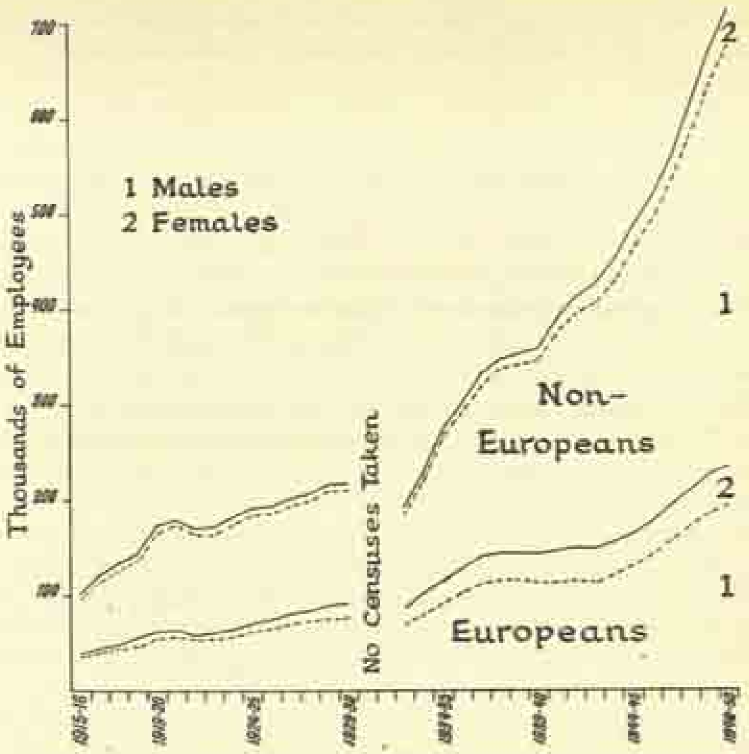


Fig. 145. The number of Europeans and Non-Europeans employed in manufacturing industry in the Union of South Africa, 1915–50.

the mines and they contributed a larger share of the national income – £269 millions compared with £159 millions. South Africa had emerged as an industrial nation.

The Opportunities for Industrial Development

South Africa possesses many advantages for industry. With vast mineral resources and a varied agriculture, a great range of industrial raw materials is produced, while the country, at the meeting place of the western and eastern oceans, is ideally situated for obtaining others, e.g. vegetable oils and oil-seeds, rubber, etc. Although opportunities for the development of hydro-electricity are lacking, enormous resources of easily-won coal facilitate the generation of thermal electricity. Iron and steel are produced at lower cost than in most other countries. The mines offer a large market for machinery and explosives and thereby support engineering and heavy chemical industries. At present the smallness of the home market limits the growth of some industries, e.g. the manufacture of fashion clothes, while all suffer from the high freight charges consequent on the great distances from the ports to the interior and from inefficient and transient labour.

Some of these disadvantages, however, will doubtless disappear as development proceeds, the living standards of the Africans are raised and markets opened in Central Africa.

The Pattern of Industrial Growth

Industrial growth has followed a very different pattern from that of the European nations or the U.S.A.

In the first place there was little development of domestic industry as a prelude to factory manufacture. Until the latter part of the nineteenth century the people were primarily concerned with the occupation of new lands and the evolution of a satisfactory agricultural economy. The climate permitted outdoor farm work throughout the year and labour was scarce. The making of wagons and furniture, the tanning of hides and the making of shoes was carried on in a small way at the Cape, but the thin spread of population, the great distances between settlements and the mercantile policy of the British Government discouraged the development of other industries.

Secondly, the growth of industry has depended to a much greater extent than in the older industrial countries on the existence of a sufficiently large home market for its products. The markets created by goldmining and the growth of towns on the Witwatersrand provided the first real incentive to industrial development. Before the end of the century a large explosives factory came into being at Modderfontein, north-east of Johannesburg, and soon after the Anglo-Boer war others were built at Somerset West and Umbogintwini. Small factories making wagons, processing food and making simple articles for the consumer market as well as service and repair shops were also established on the Witwatersrand and in the ports. The changed political conditions after the Anglo-Boer war encouraged industrial growth and the unification of the four provinces in 1910 aroused a surge of national feeling which expressed itself in a desire for industrial development and greater self-sufficiency. By 1912[3] a number of industries had been established. Fruit preserving and jam making had become important in the south-western Cape, brewing in all the big towns. Lever Bros had started the manufacture of soap in Durban and there were other small factories making soap and candles for use in the mines on the Rand, in Kingwilliamstown, and Port Elizabeth. Small-scale engineering industries catering for local needs existed in all the big towns – the manufacture of windmills, pumps and water-boring drills in Cape Town, parts for mining machinery, gates and fences in Johannesburg, stoves and Kaffir pots for the adjacent Bantu reserves in Durban. Boots and shoes were made in Port Elizabeth, Cape Town, and Wellington, tailoring and clothing manufacture was carried on in Cape Town and Johannesburg. In every case the local market was the *raison d'être* of their existence. The first world war, by curtailing imports, provided the impetus for further industrial development. In particular the needs of the mines stimulated a great expansion in the metal-working and engineering industries in the southern Transvaal, and the demand

for military boots encouraged the leather industries in Port Elizabeth while the clothing industry prospered. The end of the war, however, brought an influx of overseas manufactured goods with which the young South African industries could not compete, and only the introduction of a protective tariff in 1924 saved many of them from extinction. With a home market more or less assured under tariff protection most industries expanded slowly and steadily until the outbreak of war in 1939. After 1939 the greatly expanded home market occasioned by the second world war and later by the development of new goldfields, the mechanization of agriculture and the movement of people to the towns was largely responsible for the spectacular development of industry, already mentioned. With the return to peace-time production in Europe and North America some of the newly established industries were threatened with a loss of market but the introduction of import control in 1948 gave them the necessary protection. Since then the needs of the home market have supported an increasing diversity of industrial activity.

The importance of the market factor has been responsible for the third feature of the industrial growth of South Africa – the development of some secondary industries, notably engineering and clothing manufacture, ahead of the primary industries supplying their raw materials, which have been imported. At the same time, despite favourable geographical circumstances, the development of primary industries involving heavy capital outlay, has been discouraged by a shortage of capital, the smallness of the home market and the difficulties of competing with long-established overseas manufacturers in world markets. In the absence of local raw materials some secondary industries have been unable to develop while others have been severely handicapped in competition with overseas manufacturers. This has led to the fourth feature of industrial growth in South Africa – Government action in the establishment of primary industries, beginning with the creation of the Electricity Supply Commission in 1923 and of the South African Iron and Steel Corporation in 1928 and culminating in 1940 in the setting up of the Industrial Development Corporation as a State-sponsored financial undertaking for the purpose of assisting the development of new industries and the expansion and modernization of existing ones. Since 1945 this body has contributed large loans for the establishment of an oil-from-coal project (SASOL) near Vereeniging, the exploitation of phosphate deposits (FOSKOR) at Palabora in the northern Transvaal, the production of wood-pulp for rayon manufacture (SAICCOR) at Umkomaas, the production of paper by the Tugela river (SAPPI) and the production of textiles near Kingwilliamstown (Good Hope Textile factory).

Originally the industrial labour force in South Africa was composed almost solely of European and Coloured workers. In contrast to the early industrial phase in Europe, wages were relatively high, a factor which, by limiting the ability of South African producers to compete with overseas manufacturers, hampered growth. In the clothing industry for example, before 1939, the wages

of skilled Europeans were one-third higher than in England and the semi-skilled and unskilled Coloured workers received more than their counterparts elsewhere. These high wages were necessitated by a high cost of living caused by dear food and high transport costs on most commodities. Since 1932, however, the position has changed. With agricultural progress food has become relatively cheaper while in industry the introduction of mass production methods, made possible by the provision of electrical power, has permitted the employment of an increasing proportion of unskilled Africans. Wages have fallen relative to those in Europe and America and with a large potential African labour reserve not yet permanently occupied, further industrial growth is likely to be favoured by relatively low labour costs.

The Major Industries

Both as regards employment and net value of output the iron and steel, engineering, and metal working industries are today of outstanding importance (Figs. 146 and 147). They are followed in turn by food processing, textiles and clothing

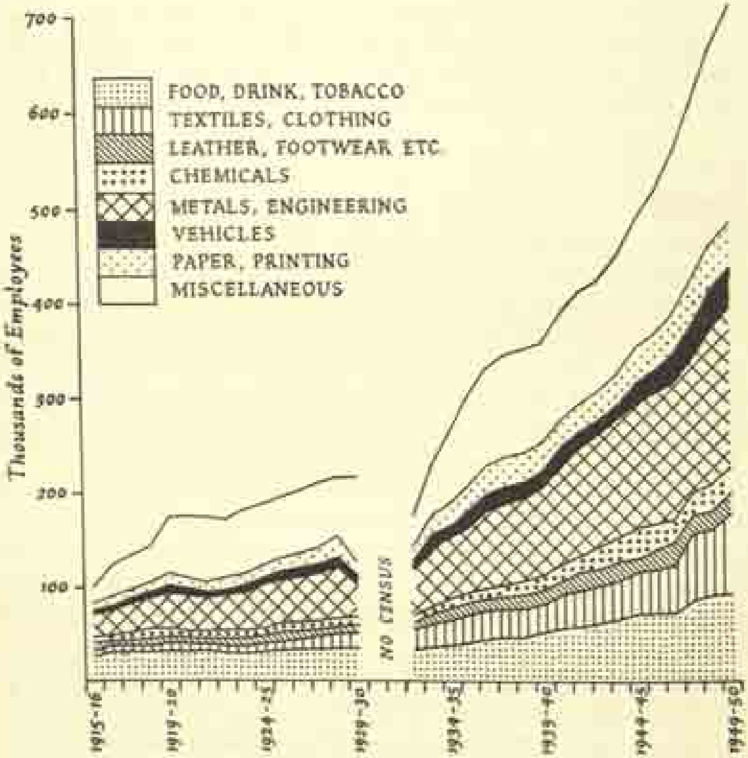


Fig. 146. The number of people employed in the leading industries of the Union of South Africa, 1915–50.

manufacture and the chemical industries. All these industries, whose development is analysed in subsequent chapters, cater essentially for the local market, and have therefore specialized in a comparatively narrow range of products for which the demand is heavy. Thus the engineering industry is primarily concerned with

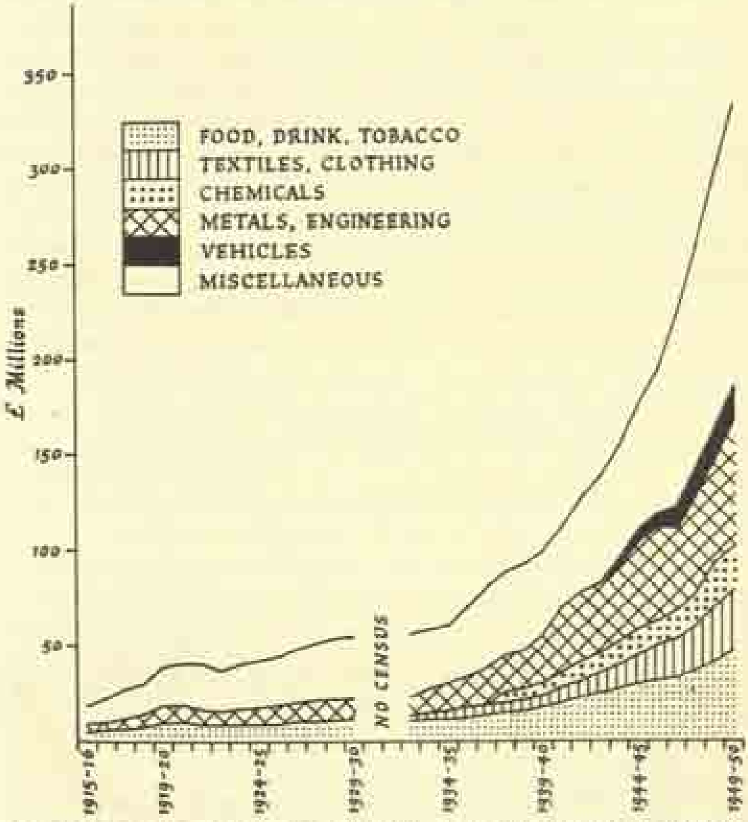


Fig. 147. The net output of the leading industries of the Union of South Africa, 1915–50.

mining equipment, the chemical industry with explosives, the clothing industry with shirts, cotton dresses and underwear. The expansion of the major industries, however, is now encouraging the development of linked or ancillary industries so that, while South Africa remains essentially a young industrial country, there is evidence of growing diversification.

The Location of Industry. The Major Centres

The location of industry has been influenced mainly by access to markets, ease of assembly of raw materials, supplies of power and water, and proximity to labour pools in that order. Even the iron and steel industry is located, not on a major

coalfield or orefield but at focal points for the assembly of all the raw materials and near the Witwatersrand market. Wool washing and wool combing is concentrated in the wool market of Port Elizabeth but spinning and weaving and the manufacture of blankets are carried on in all the major towns. As the centre of the whaling industry and port of import for vegetable oils and caustic soda, Durban

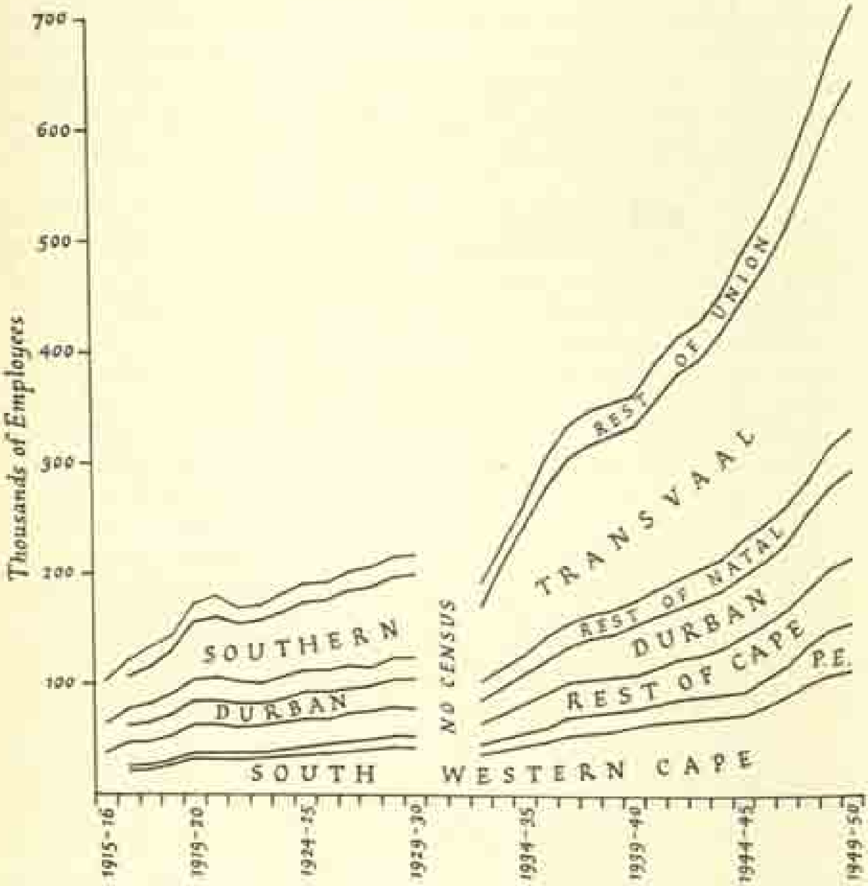


Fig. 148. The number of employees engaged in manufacturing industry in the provinces and in the main industrial areas of the Union of South Africa, 1915–50.

is the natural centre for soap manufacture, but the advantages of proximity to markets have encouraged Lever Bros to operate factories in Cape Town and Johannesburg as well, while Colgate-Palmolive have chosen East London. Only the sugar milling and refining industry of Natal is actually located at the source of the raw materials while the canning and jam-making factories are found mainly in and near the fruit-growing areas with Cape Town, Paarl, and Port Elizabeth as the

leading centres. Proximity to the market has in every case led to the development of secondary industries in the main towns, where in addition the major power pools and supplies of water are to be found. Indeed whereas in most countries industries have led to the growth of towns, in South Africa towns have attracted the growth of industries. In this the curious legal interpretation of the water laws, whereby domestic water may be used for industrial purposes within the urban areas has exerted a powerful influence. For outside the towns application for permission to use river water for industrial purposes involves expensive and often fruitless legal processes. Local coal enables electrical power to be most cheaply produced (see ch. 23, p. 389) in the southern Transvaal and there the Vaal river affords one of the best water supplies in the country. Largely because of these facilities and its focal position with regard to railways, roads, and markets, the southern Transvaal has become the most important industrial region in Southern Africa (see Fig. 148). Its growth has, however, been aided by a railways tariff (see ch. 32, pp. 491–2) designed to lessen the disadvantages of an inland situation by the granting of nearest port rates on imported raw materials. This was introduced in 1912 and amended only in 1955. Before 1912 the south-western Cape, the scene of the first industrial enterprises, was the leading manufacturing centre. Today it is second in importance, followed in turn by Durban and Port Elizabeth.

Today the industrial life of the southern Transvaal is dominated by engineering (Fig. 149), the south-western Cape by food processing and clothing manufacture (Fig. 150), and Port Elizabeth by the manufacture of boots and shoes and the assembly of motor-cars (Fig. 152). But the industrial structure of each town is essentially similar. Thus not only the major industries but also

Table 20. The Distribution of Industrial Employment in the Union of South Africa

Area	*1937–8*		*1948–9*	
	All Races		*All Races*	
	Number	*Percentage*	*Number*	*Percentage*
South-west Cape	56,197	16·1	109,628	16·4
Port Elizabeth	15,746	4·5	34,838	5·2
East London			11,575	1·7
Durban-Pinetown	36,771	10·6	74,511	11·2
Southern Transvaal	156,338	44·9	292,731	43·8
Bloemfontein			11,445	1·7
Total Industrial Areas	265,052	76·1	542,363	81·2
Rest of Union	83,468	23·9	125,857	18·8
Total	348,520	100·0	668,220	100·0

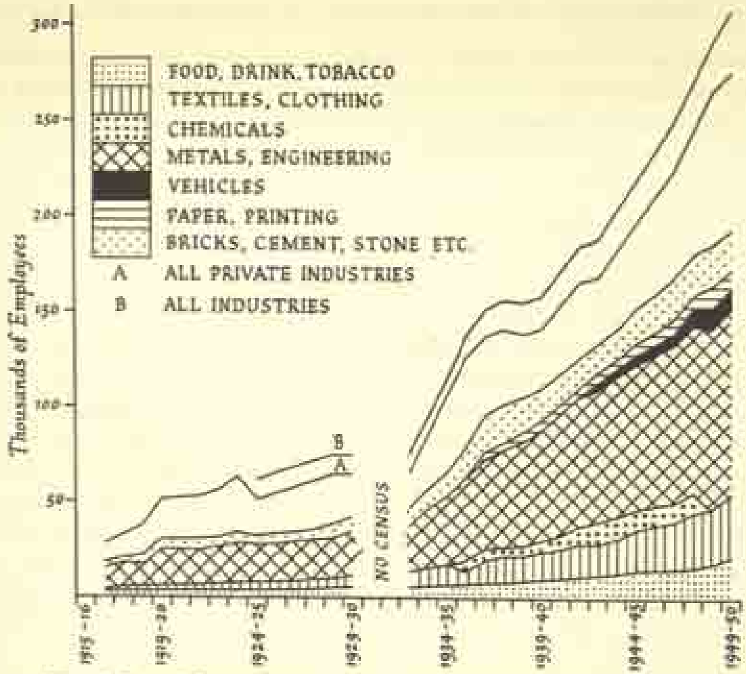


Fig. 149. The industrial structure of the Southern Transvaal; employment in the leading industries, 1915–50.

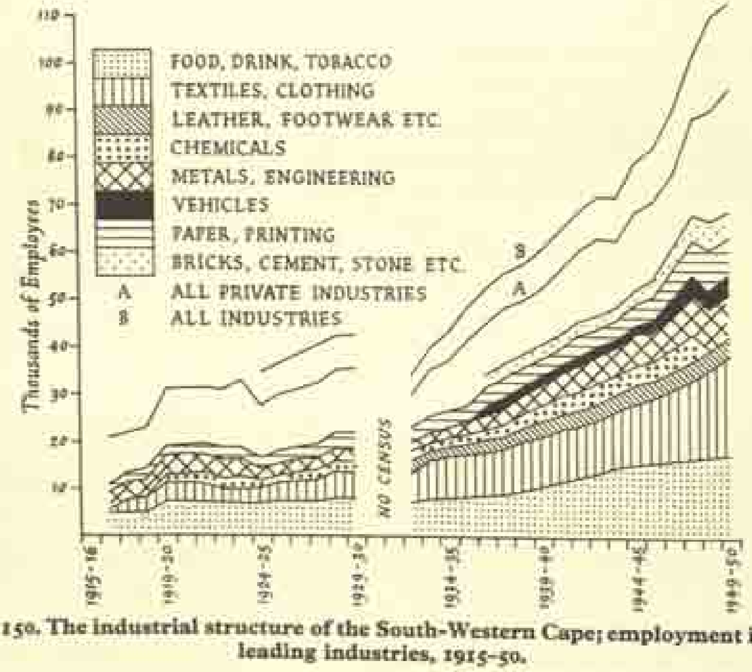


Fig. 150. The industrial structure of the South-Western Cape; employment in the leading industries, 1915–50.

sawmilling and the manufacture of furniture, printing and the preparation of packaging, and a variety of consumer industries are to be found in each centre. For this the market factor is largely responsible.

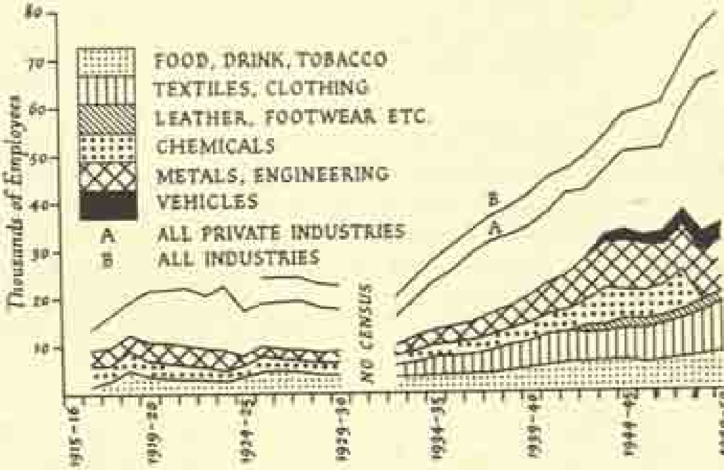


Fig. 151. The industrial structure of Durban-Pinetown; employment in the leading industries, 1915–50.

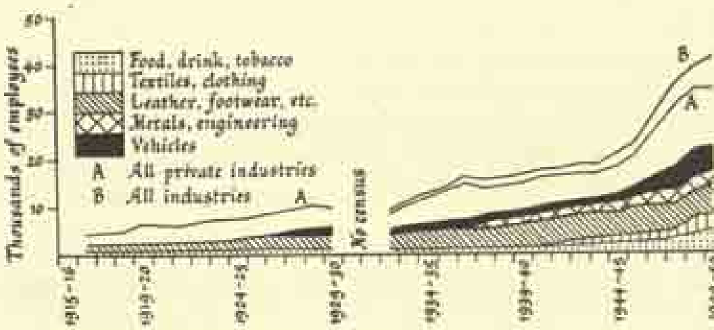


Fig. 152. The industrial structure of Port Elizabeth-Uitenhage; employment in the leading industries, 1915–50.

The rapid growth and concentration of industry in a few large centres have given rise to serious economic and social problems.

The Economic Problems

The economic problems derive mainly from the rapid rate of industrialization, the great distances between the coast and the interior and between the major centres, and the smallness of the home market.

Long rail hauls and high freight rates on imported raw materials and all

manufactured goods severely handicap all industries, particularly in the southern Transvaal, and limit their ability to compete on overseas and Central African markets. Further difficulties arise from the fact that due to shortages of rolling stock and long stretches of single line, the railways are unable to carry the greatly increased volume of freight (see Fig. 170) which industrialization has brought. In consequence acute congestion and long delays in the delivery of raw materials and in the dispatch of finished products are common. Similar congestion characterizes the ports.

The rapid rate of industrialization has led to shortages of raw materials – particularly acute in the engineering industry, which has developed ahead of the blast-furnace capacity of the country – power and water. The completion of generating stations, at present being erected, will ease the power shortage, but concern for the water supplies of the southern Transvaal has led the Natural Resources Development Council to recommend that 'no industries requiring large quantities of water and which for geographical reasons do not require to be placed there, should be permitted to establish themselves in the Vaal River Basin'.

Most industries suffer also from a shortage of skilled European artisans and intelligent African workers, arising from the fact that for long Europeans have been primarily concerned with technological work on the mines and the Bantu with manual work in the same sphere. As yet the immigration of skilled artisans from Europe has been inadequate, whilst there has been neither the time nor the opportunity for the Africans to acquire the necessary skills. The former is associated with the uncertain political situation in the country; the latter bound up with the fact that most Africans cling to their land rights in the Reserves and comparatively few have become truly urbanized. In consequence African labour is generally transient and inefficient. These questions contribute in turn to the social problems affecting the country.

The Social Problems

The social problems are more complex. Most serious are those caused by the influx of Africans into the towns where inadequate housing, inadequate transport facilities and unhappy relationships between place of work and home endanger health and lower industrial efficiency. The position has been most serious in the old industrial towns particularly Johannesburg (see ch. 40, p. 632). By contrast the newer industrial towns notably Springs and Port Elizabeth (see ch. 37, pp. 574–5) have planned their industrial and residential areas in such a way that the journey to work is relatively easy for both Europeans and Non-Europeans. Nevertheless, here as elsewhere there remains the most serious social problem of all. This derives from the system under which many male Africans become temporary workers in the towns whilst retaining their land rights in the Reserves where their wives and families remain. The breakdown of family life, lowering of moral standards and high incidence of crime are all attributable to the system.

The Future. The Decentralization of Industry

Whereas hitherto industry has been increasingly concentrated in the major towns, its dispersal is now being encouraged. In pursuance of the policy of Apartheid and desirous of improving conditions in the African Reserves and ending the present unsatisfactory position whereby many African males are separated from their families whilst working in the towns, the Government is encouraging industries on the borders of the Reserves. Moreover, the marginal belt of Natal and the eastern Cape Province and the eastern Highveld of the Transvaal offer many advantages for industry.[6, 7] They are crossed by large perennial rivers whose annual flows exceed that of the Vaal. Except in the Cape, coalfields, as yet undeveloped, should guarantee cheap electrical power. They might also lend themselves to further oil-from-coal projects, and ancillary chemical industries. Plantations of eucalyptus and pine trees already provide the raw material for wood-pulp, rayon, and paper manufacture. In the north cotton from the Transvaal Lowveld and Zululand and, in the south, wool from the hinterland of Port Elizabeth, could support local textile mills. For imported raw materials the rail haul from the ports would be considerably shorter than to the Witwatersrand. Most important industry would be near Non-European labour pools and the social problems of the Rand towns and major ports would be avoided. Already a beginning has been made, the wood pulp and paper factories (SAICCOR and SAPPI), the Good Hope textile mill, the phosphate concentrate plant (FOSKOR) representing pioneers in this direction. Industrial growth is beginning in the Tugela basin, on the Witbank and Ermelo coalfields, in Harrismith and Worcester. With the extension of essential services, particularly water and electricity, these and other centres may grow into industrial towns. All these developments may herald a new chapter in the industrial growth of South Africa. At the same time, however, the continued growth of the existing industrial centres is likely. For apart from its existing advantages the southern Transvaal is well placed to serve the markets of Central Africa as they develop, while the abolition of nearest port rates and distribution rates on the railways is likely to encourage the further development of industries using imported raw materials in the ports.

BIBLIOGRAPHY

1. Union of South Africa. Office of Census and Statistics. Census of Industrial Establishments 1938–9. Government Printer. Pretoria.
2. Union of South Africa. Office of Census and Statistics. Census of Industrial Establishments 1950–1. Government Printer. Pretoria. 1955.
3. See Report of the Commission appointed to inquire into the conditions of trade and industry. 1912.
4. F. F. WINKLE. 'The distribution of secondary industry in the Union of South Africa'. *Supp. to Comm. and Ind.*, Vol. XII, No. 9, 1954, pp. 443–56.

5. T. J. D. FAIR. 'Secondary industry in Natal'. *Comm. and Ind.*, Vol. XI, No. 3, 1952, pp. 143–54.
6. F. W. QUASS. 'The industrial potential of the undeveloped areas of South Africa'. *Comm. and Ind.*, Vol. XIII, No. 4, 1954, pp. 201–14.
7. J. L. SADIE. 'The Union reserves. Industrial areas of the future'. *Union of S.A. Finance and Trade Review*, July 1954, pp. 12–24.

25

The Iron and Steel Industries

The Growth of the Iron and Steel Industry

Iron ores are of widespread occurrence in the Transvaal, Natal, Zululand, and Griqualand where ancient workings, accumulations of slag and the remains of old furnaces[1] remind us that they were extensively worked long before the coming of the Europeans. In places the oxides – ochre and specularite – were used in the making of pigments for painting the body and powdering the hair, in others the ores were smelted and tools and weapons made. Today, in remote parts of Natal and the Transvaal, iron is occasionally smelted by the methods which have been in use probably for thousands of years, clay or ant-heap hearths and goatskin bellows being employed. The practice is, however, dying out.

While the indigenous iron industry is thus very old, the modern industry established by the Europeans is relatively young. The iron ore of Prestwick, Natal, was discovered around 1860[2] and titaniferous deposits north of Pretoria about ten years later. In 1901 a small blast furnace was erected near Pietermaritzburg but was commercially unsuccessful. In 1908 the Government Mining Engineer urged the desirability of establishing an iron and steel industry, and pointed out that steel could be manufactured at a profit from scrap iron in small electric furnaces. Between 1911 and 1916 four plants were successfully established, three of them on the Witwatersrand Goldfield and one, the Union Steel Corporation (USCO), the only one to receive government assistance, on the Vaal river at Vereeniging. All depended on the mines and the railways both for their supplies of scrap and for their principal markets.[3] The first world war severely curtailed the import of iron and steel and their consequent shortage and high price provided a great impetus for the home industry. Systematic surveys of the deposits of iron ore revealed large reserves and in 1917 two small blast furnaces were erected in Pretoria and Vereeniging to test their suitability for the production of pig iron. The Vereeniging furnace was short-lived but the one at Pretoria operated successfully until 1921. Further expansion, however, was handicapped by the post-war depression, the collapse of steel prices and the

difficulty of raising capital overseas. The introduction, in 1922, of a system of bounties to encourage the production of pig iron and steel from South African ores, stimulated the erection of a blast furnace at Newcastle in Natal, near to supplies of low-grade ore and high-grade coking coal. When nearing completion it was taken over by Usco which also built an additional steel plant on the Klip river at Vereeniging. Both the Newcastle and Klip works came into operation in 1926. This marks the beginning of commercial pig iron production in South Africa.

At first progress was slow. Despite the bounties award the Newcastle plant, located midway between the coast and the Rand, struggled to compete with overseas producers of pig iron and the Rand steelworks continued to import most of their requirements. It became increasingly apparent that an inland location, near the market and enjoying the natural protection of high transport costs on overseas imports offered the best opportunities for an integrated iron and steel works. Pretoria, where high-grade iron ore was known to occur within the townlands, was considered to offer the most favourable site. In 1925 a commission sent out by the Gutehoffnungshütte, a large German iron and steel concern, reported that a plant at Pretoria would be a commercial proposition. In the following years its establishment became largely a political issue. In 1928 an Act of Parliament created the South African Iron and Steel Corporation (ISCOR) as a public undertaking. By this time the discovery of the rich haematite deposits at Thabazimbi had lessened the locational advantage of Pretoria but political feelings precluded an impartial reconsideration of choice of location and the works was erected in the capital. It began producing in 1934. In the same year the Newcastle blast furnace, unable to compete with Iscor, was blown out.

During the 1930's increased gold-mining activity (see ch. 19, p. 303), and the growth of industry, led to an increased demand for steel. By 1937 the consumption had increased threefold; and of the 869,000 tons absorbed by the domestic market, one-third was produced in the country, 92 per cent of it by Iscor alone. In the same year the African Metals Corporation (AMCOR) was formed as a subsidiary of Iscor to take over the Newcastle blast furnace which was blown in again in 1938. At the outbreak of war, when the total capacity of the Iscor works was about 345,000 tons of steel ingots, South Africa was producing three-fifths of her iron and steel requirements despite an expanding market.

The war-time and post-war conditions accelerated the development of the industry. With mass production and standardization the output was more than doubled while the making of ferro-alloys and special steels became important. At the same time, in anticipation of a southward shift in the principal iron and steel market, Vereeniging became the most favourable location for the establishment of additional steelworks. Ferro-alloy works were established there by Amcor in 1941 and the steelworks at Vanderbijl Park by Iscor in 1943. In 1942 the production of specialized steel products began at the Scaw Alloys works in Alberton. At Pretoria and Newcastle also, the plant was extended and output increased. By 1947 the total steel output of the Iscor works reached 575,000 tons.[4] With con-

tinuing increasing demands for steel a major programme of expansion was undertaken at Vanderbijl Park and by 1955 the output of the Iscor works reached 1,500,000 tons. In eight years the output had nearly trebled. Meanwhile a new steel works has been erected by a German firm on the Vaal river at Parys but an attempt to establish a new plant using the Krupp-Renn process at Airlie in the Transvaal Lowveld failed for lack of capital. Today the South African iron and steel industry is both expanding and prosperous. Whereas steel prices in the U.S.A. and Great Britain have risen by between 60 and 100 per cent over the pre-war figures, the corresponding increase in South Africa is only 38 per cent. While the older countries face increasing difficulties with regard to supplies of raw materials, South Africa enjoys certain advantages. At this stage it is appropriate to examine the origin and supply of these raw materials.

Raw Materials

Of the raw materials used in iron and steel manufacture fuel and iron ore are used in large quantities and being bulky commodities play an important part in localizing the industry; limestone is used in lesser quantities while small amounts of a wide variety of alloy metals are also used.

Fuel

Since it takes about two tons of coal to produce one ton of steel adequate supp ies of this vital raw material are of major importance. A large proportion of the coal is used in the form of coke which must be made from blends of Transvaal and Natal coals (ch. 22, p. 380). For this reason it is more economical to carry out the coking operations at the iron and steel works than at the collieries. Access to coking coals may diminish in importance as a location factor with the development of the Krupp-Renn process, which uses duff in the preparation of sinter which is then broken up into iron nodules containing up to 94 per cent iron. Comparatively little coke is required in converting the nodules into pig iron. In 1954 more than 2¼ million tons of coking coal were used in the iron and steel industry and over one millon tons of duff in the preparation of iron nodules. It is possible that with the development of Sasol (ch. 22, p. 373), oil firing of the steel furnaces will become important. Electrical power obtained mainly from Escom (see ch. 23) is widely used in the iron and steel industry and consumption will probably increase with the further development of ferro-alloy manufacture.

Iron Ore

The Union possesses large reserves of high grade and vast reserves of medium grade iron ores (see Fig. 98). Recently important deposits have been located in South West Africa but their extent is not yet fully known.

The principal occurrences may be classified into four categories:[5]

(1) Deposits formed by magmatic segregation

(2) Replacement deposits connected with igneous rocks

(3) Deposits of sedimentary origin

(4) Deposits of the Lake Superior type.

By far the most important are those in the two latter groups.

(1) *Deposits of Sedimentary Origin*

These include the very important deposits in the Coal Measure rocks of the Karoo system and the Pretoria Series of the Transvaal System in the Union, and the recently discovered ores in the Witwatersrand, Otavi, and Damara Systems in South West Africa.

(*a*) The Coal Measure Ores: These comprise thin seams and lenses of iron ore inter-stratified with sandstones and shales. They are usually between 18 inches and several feet thick. Most important are the black-band ores of the Klip River coalfield of Natal, which outcrop along the western side of the Buffalo river valley and have been encountered in a number of collieries east of the main outcrop. The Prestwick and Springfield outliers provided the ore for the Newcastle blast furnace. At Prestwick, on the slopes of Inyanyatwa mountain, the ore body is between 3 and 10 feet thick, is nearly horizontal and in the early outcrop workings contained 55 per cent metallic iron. As the workings became deeper the iron content fell to 40 per cent. The reserves of the outliers total only a few million tons. Large reserves underlie the coalfield, but the difficulty and cost of working such a thin seam of low-grade ore at depth prohibits exploitation. It is possible, however, that adit mining in the Buffalo river valley may pay. The working of these deposits depends very much on the local demand. During the operation of the Newcastle blast furnace between 1926 and 1934 the annual output varied between 85,000 tons (in 1927) and 17,000 tons. Activities then ceased and it was not until the reopening of the works in 1938 that mining recommenced. In 1950 the output was over 77,000 tons.

(*b*) The Ores of the Pretoria Series: Iron ores occur at three horizons within the Pretoria Series but by far the most important and the only one so far exploited is the arenaceous oolitic ironstone which is inter-stratified with the quartzites and shales of the Timeball Hill horizon. It varies from 4 to 27 feet thick and has an iron content of from 40·5 to 54 per cent. Its high silica content – 18 to 21 per cent – necessitates mixing with non-siliceous ores in the older processes of iron and steel manufacture. The bed is remarkably persistent over great distances around the rim of the Bushveld basin – between Carolina and Ohrigstad it has been traced for over 180 miles – but has been worked only at Pretoria and at Airlie. At Pretoria, where large-scale operations began in 1934 with the opening of the Iscor iron and steel works, the ironstone forms the crest of the ridge south of the city. It is about 12 feet thick, dips northwards at an angle of 25° and is easily quarried. It averages 50 per cent metallic iron and nearly 20 per cent silica. The annual production exceeds 100,000 tons and the reserves are estimated at 30 million tons. At Airlie the ironstone, exposed on the lower slopes of the main plateau declining to the Elands valley, is up to 27 feet thick, dips

at an angle of only 6° to the north-west, and is easily quarried.[6] The iron content averages 47·6 per cent with values up to 65 per cent and the silica 24 per cent. Sulphur and phosphorus occur only in negligible quantities. The reserves are estimated at 118 million tons, of which 18 million tons are actually exposed at the surface. The total reserves of ore containing 30 to 54 per cent iron and 14 to 25 per cent silica on the Timeball Hill horizon are estimated at 131,840 million tons.

(*c*) The Ores of South West Africa:[7] Sedimentary iron ores have been located at a number of localities in South West Africa. Near Otjosondu ores containing 58 to 59 per cent iron and about 18 per cent silica occur in quartzitic inliers of Witwatersrand age which protrude through the rocks of the Otavi system to form prominent monadnocks; north-west of the Swakopmund–Tsumeb railway the Otavi dolomite contains limonite, whose low grade is offset by its self-fluxing nature, while to the south of the Kunene the same formation, here folded into a series of north–south trending wide synclines and low anticlines, contains a siliceous ore zone which is exposed on erosional scarps marking the flanks of the synclines. In one place the thickness of good grade ore exceeds 150 feet. The reserves of ore, containing more than 40 per cent iron are estimated at 100 million tons and there are more than 1,000 million tons with at least 30 per cent iron. American steel companies have large mineral concessions in this area and have accomplished much exploratory work but owing to the isolated, inhospitable nature of the country, the provision of water and of hydro-electric power from the Kunene river and the development of a new direct outlet to the sea must precede commercial mining operations. South-east of Windhoek and near Walvis Bay siliceous ores occur in the Damara System, which in the latter locality merely protrudes through the desert waste. In each area the iron content of the ore is only about 40 per cent but with selective mining, sorting, and beneficiation this could be raised to between 57 and 60 per cent and the greater accessibility of these ores holds promise of their early exploitation. In all cases iron ore mining depends on an overseas export market for the territory is remote from the iron and steel centres of the Union and opportunities for the development of a local industry are lacking.

(2) *Deposits of the Lake Superior Type*

The haematite deposits of the Lake Superior type, i.e. secondarily enriched sedimentary ores, which occur on either side of the Crocodile river at Vliegepoort, north of Rustenburg in the Transvaal and near Postmasburg in Griqualand West, constitute the most important iron ores of South Africa.

The Crocodile river iron deposits comprise lenticular or tabular ore bodies ranging up to 1,000 yards in length and 50 feet in thickness, occurring at the top of the Dolomite Series. They have been worked at Thabazimbi (iron mountain) by Iscor since 1931, although the railway from Northam was opened only in 1934. Situated on the hill, about 1,000 feet above the railhead, the workings (Plate 67)

consist mainly of tunnels and open face quarries and are connected to the railway loading bins by a self-acting incline a mile long laid diagonally across the steep hill face. The haematite is exceptionally pure, containing an average of 66 per cent metallic iron and only 3 per cent silica and 0·03 per cent phosphorus. However, because it is very dense and close-grained it is difficult to smelt while the silica content is so low that the slag is insufficiently viscous to flow readily when drawn from the furnace. Consequently this high-grade ore has to be mixed with easily-reducible siliceous ores at the iron and steel works. The greater part of South Africa's iron ore production, which in 1953 exceeded 2 million tons, came from Thabazimbi, where the reserves at the Iscor quarry alone are estimated at 30 million tons.

The haematite ores of Griqualand West comprise numerous scattered deposits in an area extending from Postmasburg northwards for some 40 miles. They are contained in brecciated banded ironstones and conglomerates of Lower Griquatown age. The former, being highly resistant to weathering, cap isolated hills and ridges, and vary in thickness from a few feet to a rare maximum of 25 feet. The ore is so broken by natural agencies that most of it is of a convenient size for loading. The conglomerates occupy depressions and sink-holes in the uneven dolomite surface in which the Lower Griquatown beds were laid down. The ore bodies are lenticular, but in places attain a thickness of 50 feet or more. In both cases the ore averages 60 per cent metallic iron, 3·3 per cent silica, and 0·10 per cent phosphorus. Although closely associated with important manganese deposits, it rarely contains as much as 0·5 per cent of this metal. The ore reserves in this area, totalling 28 million tons, are at present being worked only at Manganore by the African Metals Group and at Sishen where Iscor is working a large conglomerate mass (Plate 68).

(3) *Other Iron Ores*

Enormous deposits of titaniferous magnetite, estimated to comprsie at least 2,000 million tons, occur within the norite of the Bushveld Igneous Complex in the Transvaal and in the Tugela valley in Natal. The ore bodies, formed by magmatic segregation, are up to 12 or even 20 feet thick and in the Transvaal may persist for up to 10 miles. They contain 50 to 60 per cent metallic iron but the presence of titanium, ranging from 12 to 20 per cent, which is difficult to separate in the blast furnace, has hitherto prevented their exploitation. Possibly, however, the introduction of the Krupp-Renn process, which permits the complete separation of the titanium from the iron, coupled with the growing demand for titanium consequent on the discovery of new uses for the metal, may alter the picture in the future.

The remaining iron ore deposits are not of economic significance.

The total 'probable' available reserves of iron ore in the Union have been tentatively estimated at 6,000 million tons, of which 120 million tons represent high-grade haematite containing 60 per cent metallic iron, low in silica, sulphur,

and phosphorus, while the remainder comprise various types of ore averaging 40 to 60 per cent metallic iron and 5 to 25 per cent silica, the greater part of it represented by the siliceous sedimentary ores of the Pretoria Series. These reserves are exceeded only by those of the U.S.A., France, Brazil, and India. Of suitable grade for present metallurgical practice, they are sufficient to satisfy the country's iron and steel industry for a very long period, even if allowance is made for considerable expansion. In addition reserves of titaniferous ore have been conservatively estimated at 2,000 million tons while potential reserves of iron ore averaging less than 40 per cent iron and high in silica have been estimated at 2 billion tons. These are of no economic significance at present but represent a potential reserve which may eventually become available by some process of beneficiation.

Other Raw Materials

Other raw materials used in the iron and steel industry include limestone, dolomite, refractories, manganese ore, alloying metals, and scrap iron. South Africa is not well endowed with metallurgical limestone (see ch. 21, pp. 342–3) which occurs only in remote areas, but possesses large reserves of manganese, nickel, and chrome ores and adequate supplies of tungsten (see ch. 20). Supplies of scrap come mainly from the mines and the railways.

Iron Smelting and Steel-making Districts

From the foregoing it is apparent that in South Africa the sources of the major raw materials for iron and steel manufacture – iron ore, coal, and limestone – are widely separated, while for coke production coal must be blended from two coalfields more than 200 miles apart. In consequence the major iron and steel centres are not on the coalfields, their location having been determined mainly by (1) ease of assembly of raw materials and fuel, (2) proximity to markets, (3) availability of water supplies. The first mentioned is particularly important for iron smelting works which consume between 3 and 3½ tons of raw materials and fuel per ton of pig iron. Iron ore constitutes the largest single item but since the major ore fields, i.e. at Thabazimbi and Postmasburg, are in remote semi-arid country they have not attracted smelting works. The works at Pretoria, however, are located on an ore-field. Generally speaking focal points for the assembly of raw materials and sites with unlimited supplies of water are most favourable, and such locations are occupied by the Pretoria, Vanderbijl Park, and Newcastle works. The steel-making industry uses iron either in molten or pig form and scrap metal as its main raw materials and small quantities of alloy metals; for some processes electricity is the most desirable form of heat. The industry therefore favours locations (*a*) adjacent to smelting works, where molten iron from the blast furnaces can be converted directly into steel so that 'integrated' works are possible – as at Pretoria and Vanderbijl Park, (*b*) where scrap is abundant as on

the Witwatersrand where supplies come from the mines and railways, (*c*) near markets as on the Rand where the output feeds the engineering industries, (*d*) at focal points for the assembly of iron and alloy metals and dispatch of special sheets for engineering purposes – Vereeniging and Alberton, and (*e*) where electric current is plentiful and cheap as in the Vereeniging area.

The establishment and growth of the main centres (see Fig. 153) represent responses to changing geographical values. Steel making preceded pig-iron production and hence the first industry developed on the Witwatersrand where scrap was available and a market at hand. The first pig iron was manufactured at Newcastle where supplies of iron ore, coking coal, and limestone were found in close proximity. The first large iron and steel works was built at Pretoria adjacent to the only large reserves of iron ore known at the time of its conception and near the main market. With the discovery of the Thabazimbi and Postmasburg iron ores, the growing importance of alloy metals, and the shift in the market southwards, the Vereeniging-Vanderbijl Park area, blessed with greater water resources than Pretoria, developed. Recently with the knowledge that the waters of the Vaal will soon be fully utilized, and with the development of the Krupp-Renn process making possible the utilization of low-grade quartzitic ore, attempts have been made to establish a new centre at the foot of the Great Escarpment in the eastern Transvaal.

The Pretoria Iron and Steel Centre

The initial choice of Pretoria as a centre for an integrated iron and steel industry depended on the local iron ore deposits (see Plate 69). Coking coal had to be brought 70 miles by rail from the Witbank coalfield and 270 miles from the Klip river field, while the nearest steel market in Johannesburg lay 40 miles to the south (see Fig. 154). Before the works came into operation the richer Thabazimbi iron ore deposits, 150 miles by rail to the north-west, were discovered and within a few years 75 per cent of the requirements were derived from this source.[8] Today this has risen to 90 per cent. At first 75 per cent of the coking coal requirements were furnished by the Witbank field but with improvements in the method of coking, the proportion rose to 97·5 per cent; subsequently, with the use of coal from No. 5 seam, as well as No. 2 seam (see ch. 22, pp. 354–9), it has fallen to 80 per cent. Small quantities of dolomite from the nearby Quaggapoort quarry are used as flux in the blast furnaces and, calcined, as lining material in the steel furnaces, but the major requirements of blast furnace limestone have to be brought 120 miles by rail from Marble Hall, to which a railway was constructed from Tuinplaats in 1934, and of steel furnace lime 317 miles from Taungs. Other raw materials are used in small quantities and exert no influence on the industry's location. Fluorspar is obtained from the Warmbaths district, manganese from Lohathla, zinc from Broken Hill in Northern Rhodesia, graphite from Zoekmakaar, talc from Kaapmuiden, acids and chemicals from Modderfontein, and refractory materials from Olifantsfontein, Vereeniging, and overseas.

The initial plant comprised a battery of 57 coke ovens with a daily capacity of 450 tons of coke, a by-product plant, one blast furnace with a daily output of 500 tons of pig iron, two steel melting furnaces each of 100 tons capacity and a mixer of 400 tons capacity and two electric rolling mills of comprehensive type, able to turn out 150,000 tons of rails, sheets, bars, wire, etc., annually. The plant was designed to utilize the waste heat for generating compressed air, heating the blast furnace stoves and the steel furnaces, and for generating electricity. In order

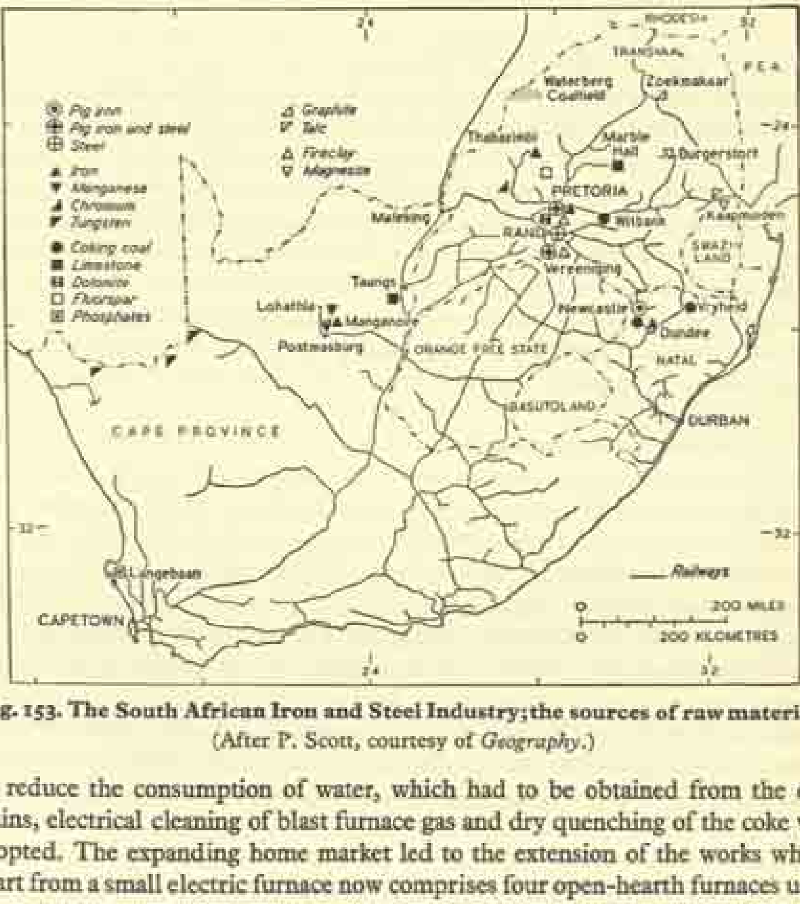


Fig. 153. The South African Iron and Steel Industry; the sources of raw materials.
(After P. Scott, courtesy of *Geography*.)

to reduce the consumption of water, which had to be obtained from the city mains, electrical cleaning of blast furnace gas and dry quenching of the coke was adopted. The expanding home market led to the extension of the works which apart from a small electric furnace now comprises four open-hearth furnaces used in conjunction with two acid Bessemer converters in the duplex process of steel production, to give a daily output of about 1,400 tons of steel. The rolling mills consist of a blooming mill with an annual capacity of 800,000 tons, heavy and medium rail and structural mills, light merchant bar and rod mill, small sections mill, sheet mill, wire works, and a 3,000-ton forge press, with an overall capacity of 460,000 tons of rolled, drawn, and forged products per annum.

By 1939 it became apparent that any large-scale expansion at Pretoria would

be limited by lack of space on the existing site and by the doubtful adequacy of the water supply. Moreover the initial advantage of the location had disappeared with the greater use of Thabazimbi ore, while the development of the Far West Rand and the possible extension of gold mining to the Orange Free State indicated a southward shift in the steel market. Accordingly Iscor decided to build a new works with a township for its workers near the Vaal river, and in 1941 purchased 40 square miles near Vereeniging. Further expansion of Pretoria as an iron and steel centre is unlikely.

The Vereeniging Iron and Steel Centre

When Usco established its steelworks by the Vaal river at Vereeniging in 1913 the location had little to commend itself, being remote from the principal raw materials and from the main steel market. With the opening up of the Postmasburg iron ore and manganese deposits, the establishment of electricity generating stations along the Vaal river (see ch. 23) and the southward shift in mining activity, however, the locational advantages of the Vereeniging area, able to draw directly on the water resources of the Vaal river, have steadily increased. The production of steel has always been the first concern and although pig iron is now made at the new Iscor works at Vanderbijl Park, increasing specialization in the production of special steels, ferro-alloys, etc., favoured by the abundance of cheap electrical power, is evident.

At first the Usco works used only railway scrap, but after 1926 the consumption of pig iron increased. Between 1926 and 1934 Newcastle pig iron formed 22 to 30 per cent of the charge. In 1934 Iscor obtained a controlling influence in Usco and between 1934 and 1938 provided 40 per cent of the iron requirements of Usco which now concentrated on steel foundry work, forging, and the production of special steels. After its reopening in 1938 the Newcastle blast furnace supplied 50 per cent of the requirements. During the war, with Iscor drawing upon the limited supplies of scrap available, an increasingly high proportion of pig to scrap became necessary, while specialization became more marked. At present Usco operates two works, one by the Vaal river comprising three open-hearth furnaces, three electric furnaces and a rolling mill and another by the Klip river comprising seven electric furnaces, a cogging mill, a finishing mill, and a continuous rod mill. Of a combined output of nearly 100,000 tons the Vaal works produces four-fifths, mainly rolled sections and castings, and the Klip works one-fifth, mainly hollow drill steel, steel, and copper wire. Bolts, nuts, and rivets are manufactured by a subsidiary company.

In 1942 the Vereeniging Ferro-Alloy works were established by Amcor to take over from the Newcastle blast furnace the production of ferro-manganese with a low carbon content and to produce for the first time in South Africa other ferro-alloys. The initial plant comprised four electric furnaces. Since ferro-manganese with a high carbon content is more efficiently made in blast furnaces, its production has remained in Newcastle. Manganese ore comes from Postmas-

burg, chrome ore from Amcor's own mines near Northam and from Southern Rhodesia, high-grade quartz, used in ferro-silicon production from several localities in the Transvaal. Dolomite is obtained from Lyttleton. With the increasing demand for ferro-manganese both at home and overseas, the works are being

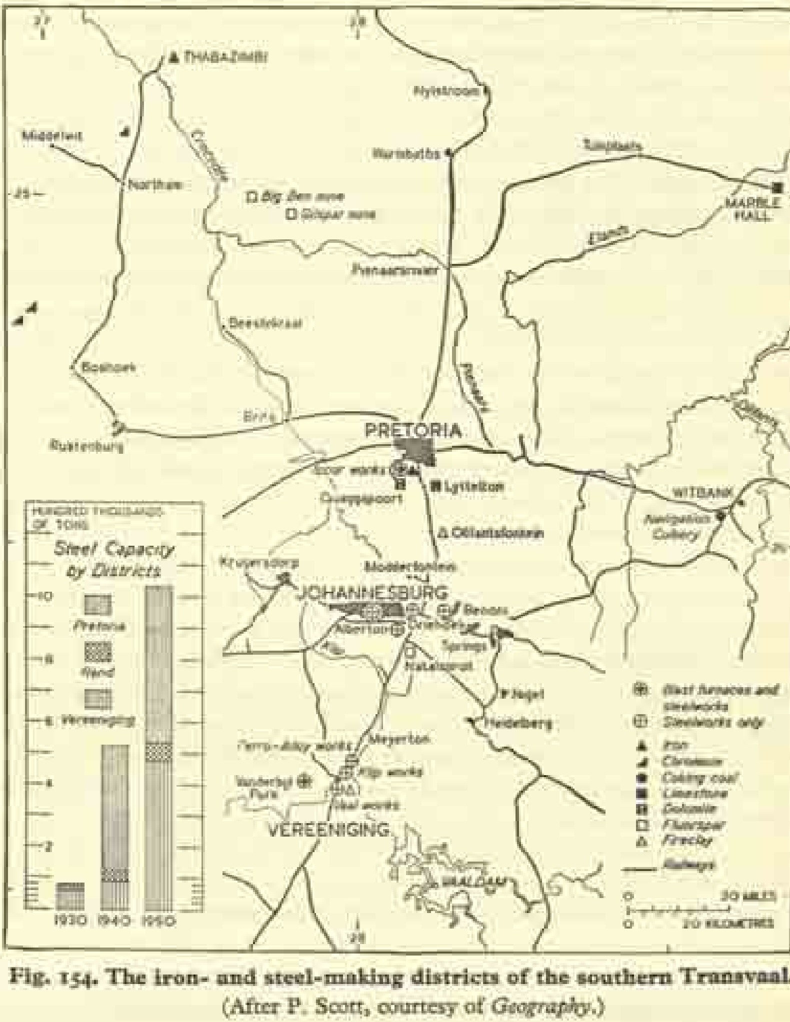


Fig. 154. The iron- and steel-making districts of the southern Transvaal. (After P. Scott, courtesy of *Geography*.)

transferred to a larger site, of 1,150 acres, near Meyerton about seven miles north-east of Vereeniging, where two additional electric furnaces have been installed. At present ingots as well as ferro-alloys are produced but when the Vanderbijl Park steelworks reach full production, the output will consist entirely of ferro-alloys, tungsten carbide, and mild and stainless steel.

The Vanderbijl Park iron and steel works[3] occupy a 6,100 acre site by the Vaal river. The initial plant, comprising a battery of coke ovens, two blast furnaces, five open hearth furnaces, and rolling mills, came into operation in 1951 with an ingot capacity of 350,000 tons per annum and a rolling capacity of 240,000 tons. Expansion to an ultimate output of one million ingot tons is planned. The plant will then comprise seven batteries of by-produce coke ovens, each with a daily capacity of 600–700 tons, four blast furnaces each with a daily output of 800–850 tons pig-iron, ten open-hearth furnaces with Bessemer plant operating on the duplex process, a combined blooming and slabbing mill, a medium plate mill, semi-continuous hot strip and cold strip mills for sheets and tinplate, heavy and light section mills, for structural sections and rails, merchant bar mills, and possibly a wide plate mill. The raw materials are obtained from the sources supplying the Pretoria works. Tin-plate production began in 1951 and is planned to meet the needs of the country's rapidly expanding canning industry.

The Witwatersrand Steel Centre

Although the Witwatersrand is the oldest steel centre in the Union, operations at the four works located in the area remain on a small scale and are concerned primarily with the specialized needs of the mines. All the works use steel scrap supplemented whenever necessary with Iscor and Amcor pig-iron, and use electric heat for smelting. The Dunswart Iron and Steel Works, established at Benoni in 1911, originally produced wrought iron but after 1920 went over to the production of high-grade basic steel. Its present output is around 29,000 tons of merchant sections and steel castings which are sold mainly to the mines and railways but also to customers in the Rhodesias and Mozambique. In Johannesburg the works of George Stott & Co., dating back to 1910, produce merchant bars for engineering works and the mines. The Driehoek works established under the aegis of the Chamber of Mines in 1916, and Scaw Alloys Ltd, located at Alberton in 1942, produce steel balls for rolling mills and shoes and dies for stamp mills, while the latter firm is experimenting in the production of ferro-alloys from the titaniferous iron ores of the Bushveld.

Newcastle Iron Centre

The possession of local supplies of Coal Measure ironstone and straight coking coal favoured the establishment of an iron industry on the Klip river coalfield in the early 1920's. The site chosen at Newcastle, by the Ncandu river and adjacent to the main railway line, offered an adequate water supply and facilities for the cheap assembly of raw materials, while its position midway between Johannesburg and Durban promised markets both in inland and coastal areas. The high cost of distributing the finished products, however, hampered development. Until the second world war overseas producers could undersell South African pig iron in coastal markets and could even compete successfully on the Rand. Between 1926 and 1934, when Newcastle was the sole producer of pig iron in the country, the

output surplus to the requirements of the Usco works at Vereeniging could not be sold in sufficient quantities to keep the plant in continuous operation. With the opening of the Iscor works in 1934, the Newcastle works closed down but the subsequent expansion of the home market led to its re-opening in 1938. The war brought new demands and in 1945 a new mechanically operated furnace was blown in and the old hand-loaded one closed down. Since 1938 the entire output has found a ready market in the Vereeniging and Rand steelworks, on the mines and the railways. In 1949 the output of pig iron totalled 150,000 tons and despite the small size of the works and less mechanization and vertical integration, the production costs compared favourably with those at Pretoria.

Meanwhile changes have occurred in the sources of raw materials. At first limestone was brought some 400 miles from Taungs; later dolomite from Natalspruit was successfully substituted, and today dolomite is obtained from Lyttleton. But while nearer sources of limestone have been found the works have had to go further afield for their major raw materials. The richer and more accessible local ores at Prestwick and Springfield have been nearly worked out, while the coking coal output of the nearby collieries goes either to the Pretoria iron and steel works or is exported as steam coal. Between 1938 and 1948 about two-thirds of the ore requirements came from Thabazimbi but since 1948 when, in response to the ever-expanding market, the original blast furnace resumed operations, Manganore has become a major source of supply. Coke is brought 115 miles by rail from the Vryheid coalfield, where until recently the low volatile content of the coal had precluded the use of by-product coke ovens. Today coke is cheaper at Pretoria than at Newcastle. Manganese for the production of high carbon ferromanganese is brought from Postmasburg; the increased haulage makes it more expensive than at Vereeniging, but suitable blast furnaces and proximity to Durban for export have so far offset this disadvantage.

The Elands Valley Iron and Steel Centre

Several years ago an attempt was made to establish an iron and steel industry at Airlie in the Elands valley in the Transvaal Lowveld. This site offers exceptional advantages for the assembly of raw materials. Medium-grade iron ore, suitable for beneficiation by the Krupp-Renn process, is easily quarried above Airlie, duff coal may be brought by rail down-grade from Witbank, 80 miles to the west, and dolomite is available from a quarry eight miles away; the Elands river affords ample supplies of water. The area lying below the Great Escarpment is more than 150 miles from the main inland market but the estimated costs of producing pig iron at £2 10*s.* per ton and steel ingots at about £5 10*s.* per ton, the lowest anywhere in the world, left a wide margin of profit after delivery to the Rand and the coast. The proposed plant comprised one Krupp-Renn kiln for the production of iron nodules, a Dr Thomas furnace for converting the iron nodules to pig iron, a mixer and two Bessemer converters for steel manufacture, and various rolling mills. The steel plant had a planned capacity of 48,000 tons per annum

and provision was made for increasing the output to 120,000 tons by the addition of another kiln and more steel plant. Insufficient capital, however, was forthcoming and the project was abandoned.

Future Trends

The main problems confronting the future development of the industry concern the adequacy of the coking coal resources and the water supply. The iron ore reserves are enormous and alloy metals abundant. The proved coking coal reserves are limited but large deposits of blend coking coal and non-coking steam coal are known to exist in the Waterberg coalfield north of Thabazimbi and straight coking coal may be found in the as yet little known Utrecht coalfield. If, however, the Krupp-Renn process of iron smelting proves practicable and is widely used, the coke requirements will decrease. Water supplies pose a more serious problem, particularly as the resources of the Vaal river will probably be fully utilized by 1975. The eastward-flowing rivers, however, carry large volumes of water (see ch. 7, p. 153) and since huge reserves of iron ore occur in the eastern Transvaal not far from the major coalfields, the development of a large-scale industry in this area seems likely. With cheap electricity and adequate water the Vereeniging area seems destined to become important not only for iron and steel production but also for the manufacture of ferro-alloys—ferro-manganese, ferro-silicon, ferro-chrome, ferro-tungsten, and ferro-titanium—for all of which the Union possesses abundant raw materials. Further large-scale expansion at Pretoria, on the Rand, and at Newcastle is unlikely.

The importance of the iron and steel industry in the national economy cannot be over-estimated. The greatly increased supply of cheap steel made possible by the Iscor works has aided the development of the new goldfields, and provided the raw materials for an expanding engineering industry which in turn has facilitated the mechanization of agriculture, the development of secondary industry, and the expansion of transport facilities.

BIBLIOGRAPHY

1. P. A. WAGNER. *The Iron Ore Deposits of the Union of South Africa.* Geol. Surv., Mem. No. 26, Pretoria, 1925, p. 13.
2. *The Mineral Resources of the Union of South Africa.* Dept of Mines, Geol. Surv., Pretoria, 1940, p. 326.
3. P. SCOTT. 'The iron and steel industry of South Africa'. *Geog.*, Vol. XXXVI, Pt 3, No. 173, July 1951, pp. 137–49.
4. 'Iscor's importance in the Union's economy'. *S.A. Min. Eng. J.*, Vol. LXIII, Pt 1, Mar. 15, 1952, p. 73.
5. See *Mineral Resources of the Union of South Africa.*

6. 'The Krupp-Renn process and the Union's iron ores'. *S.A. Min. Eng. J.*, Vol. LXIII, Pt I, Mar. 1, 1952, p. 7.
7. 'Iron ores in South West Africa'. *Industrial Minerals*, Union Dept of Mines, Quarterly Information Circular, Jan–Mar. 1954.
8. P. SCOTT. 'The iron and steel industry of South Africa', from which much of the information in this section is taken.
9. 'The new Iscor works'. *S.A. Ming. Eng. J.*, Vol. LXI, Oct. 1950.

26

The Metal-working and Engineering Industries

The metal-working and engineering industries are of outstanding importance both as regards employment and value of output. In 1949–50 they employed over 182,000 people – more than 25 per cent of the total employed in industry and twice as many as the food industries (see Fig. 146), the next largest group – and yielded a net output of over £84 million, about one-quarter of the net industrial output (see Figs. 147 and 156). The vehicle industries employed a further 43,000 people and had a net output of over £20 million. This pre-eminence is, however, recent, the food industries being eclipsed as the leading group only in 1934. Prior to this date metal working and engineering activities were largely confined to service and repair work and to the manufacture of spare parts for mining equipment and of galvanized articles for the plumbing trade. Indeed of the total of 49,000 employed in these industries in 1933 nearly 17,000 were actually engaged in mine workshops and over 11,500 in railway workshops (Fig. 155). In most cases any actual manufacturing was on a jobbing basis and apart from small quantities of steel obtained from local steelworks on the Rand, iron, steel, and non-ferrous metals were imported.

Most metal-working and engineering industries depend on cheap iron and steel of the requisite quality and section, and hence their growth in South Africa, as in most countries, has hinged on the development of the iron and steel industry. Pig iron was first produced in Vereeniging and Newcastle in 1926; next year Stewarts and Lloyds began the manufacture of weldless steel tubes in the former centre, but it was not until after the establishment of the Iscor iron and steel works in Pretoria in 1934 that any large-scale developments were possible. The actual erection of the steelworks stimulated the structural engineering industry which extended its activities after the coming into operation of the plant.[1] The fabrication of metal products and machinery followed. By 1939 the manufacture of iron and steel pipes and tubes, structural steelwork, wire fencing, and gates and wheelbarrows, none of which are exacting in their raw material requirements or

precision of execution, had become important while a start had been made in the production of agricultural and mining machinery, nuts, bolts and rivets, chains and wire ropes. The second world war stimulated a tremendous expansion in the metal-working and engineering industries which was made possible by a greatly increased output of iron and steel from Iscor's enlarged works at Pretoria and new works at Vanderbijl Park. At the same time the production of a greater variety of type and section of iron and steel and the production of ferro-alloys at new works at Vereeniging and Vanderbijl Park permitted the manufacture of an extended range of articles. In the post-war years the general world shortage of steel and machinery at a time when new goldfields were being developed and farming was becoming mechanized ensured the continued expansion of the engineering industries. Not only did established firms increase the scale of their activities but they were joined by newcomers, mostly offshoots of parent British and American firms. At the same time important changes took place in the organization of the industry. During the war many small firms hitherto concerned with engineering or metal working only on a jobbing basis began manufacturing. In many cases expansion took place in existing buildings often on restricted sites in the centres of towns, particularly Johannesburg, Durban, and Cape Town. Equipment was difficult to obtain and often of a makeshift nature. After the war the more successful of these firms moved out to spacious sites in new industrial townships, where

Table 21. Union of South Africa. The Output of Certain Engineering and Metal Products

	1937–8 Quantity	*Value £000*	*1949–50 Quantity*	*Value £000*
Iron and steel pipes, tubes, fittings (000 tons)	49·0	1,343·7	106·9	5,157·9
Bolts, nuts, washers, screws, rivets (million lb.)	8·4	122·2	34·7	1,204·8
Structural steel work (000 tons)	46·2	1,347·4	92·3	5,613·9
Reinforced metal work (000 tons)	22·6	614·5	35·3	1,785·9
Metal doors and windows	*	460·2	*	2,570·0
Wire (000 tons)	*	*	82·1	5,139·6
Wheelbarrows (000's)	38·9	45·8	47·0	145·7
Rockdrills and parts (000 tons)	0·9	373·8	8·2	2,665·0
Tube-mill liners and spares	*	*	*	850·9
Other mining machinery and parts	*	*	*	4,650·8
Agricultural machinery	*	98·0	*	1,883·7
Other machinery manufactured	*	*	*	3,069·0
Vehicles, tractors assembled	*	*	*	443·8
Other machinery assembled	*	*	*	2,188·2
Canisters, containers	*	*	*	5,547·3
Other galvanized iron articles	*	888·7	*	2,551·4
Electric wire and cables	*	*	*	5,599·0
Transformers, switchgear, control gear	*	*	*	941·0
Primary batteries	*	*	*	431·0
Electric incandescent lamps	*	*	*	312·0

* Information not available.

modern buildings were erected and efficient equipment installed. Here they were joined by the newcomers from overseas. In this way modern engineering and metal-working industries were established. By 1950 such had been the development (Table 21) that a large part of the country's needs of heavy iron and

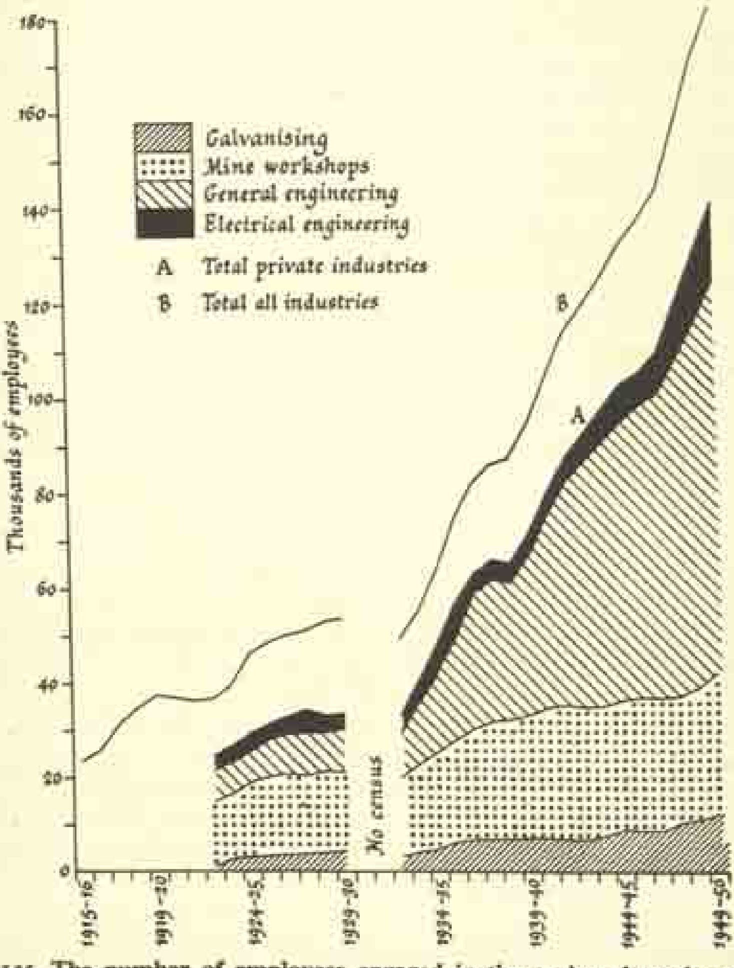


Fig. 155. The number of employees engaged in the various branches of the metal-working and engineering industries of the Union of South Africa, 1915–50.

steel products, bolts and nuts, mining machinery, agricultural machinery, and light metal products were being met while there was a small export of agricultural and mining machinery and of electrical cable and wire.

The location of the engineering and metal-working industries has been influenced mainly by the cheapness of assembly of raw materials and by access to

markets. The Southern Transvaal, containing the major iron and steel centres and the main mining markets and adjacent to the best arable farming country, the main market for agricultural machinery and implements, is of outstanding importance. In 1949–50 one-half of the people engaged in the engineering and metal-working industries were employed there. For certain branches of these industries, e.g. non-ferrous metal industries, however, the coastal towns are more important. Within the southern Transvaal there is some areal specialization. Thus since the development of the Vanderbijl Park iron and steel works the Vereeniging

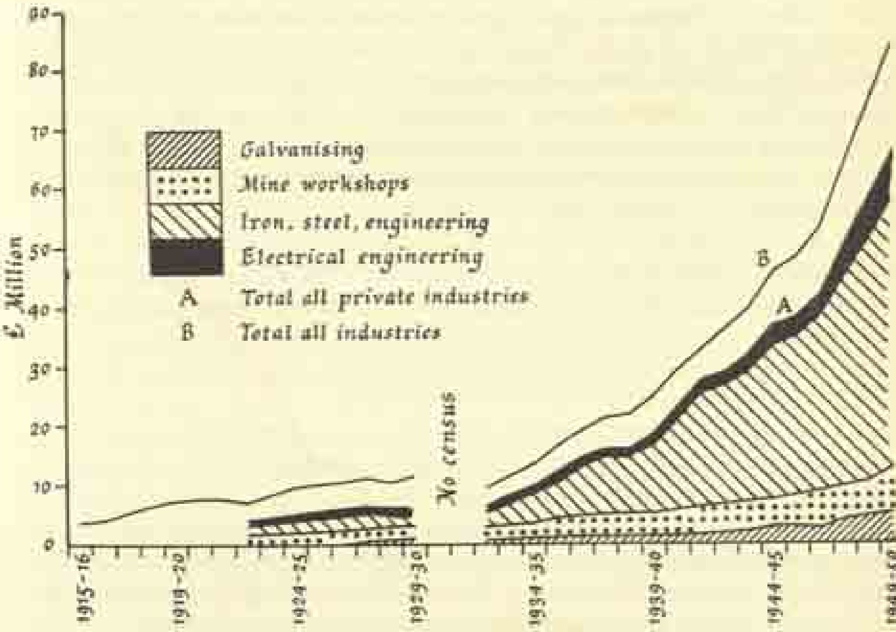


Fig. 156. The net output of the various branches of the metal-working and engineering industries of the Union of South Africa, 1915–50.

area has tended to become increasingly important for the heavy engineering and metal industries. The Witwatersrand, on the other hand, is pre-eminent in light engineering and in the production of mining machinery and parts, trends likely to continue by reason of its great consuming market and its central position in relation to all the goldfields.

The metal-working and engineering industries are not yet able to supply all the country's varied needs. Specialization along certain lines has necessarily occurred, being influenced mainly by the size of the home market, the materials available, and the skill of the labour force. In some instances the lack of steel of the requisite grade or section or of non-ferrous metals of a particular quality has hampered development; in others efficient production has been prejudiced by

congested conditions in factories which have outgrown their original function. In most cases the interplay of all these considerations has led to specialization in particular centres.

The Manufacture of Metal Products

Light Fabricated Metal Products

The manufacture of such articles as wheelbarrows, gates and fences, metal doors and windows, and windmills has been carried on for a long period, being encouraged by the local market and helped by duties ranging from 15 to 20 per cent on similar imported goods. Today all the country's needs are met by local factories. Since the war the developing market has encouraged the production of agricultural implements although no protection has been possible owing to the Government's policy of keeping agricultural costs at the lowest possible level. Despite this, production now largely satisfies home needs and there is a small but growing export of ploughs, cultivators, and planters. Altogether there are about fifty firms engaged in the production of light fabricated metal products, most of them being located in the southern Transvaal. The basic raw materials are obtained from local sources but fittings and non-metallic materials are usually imported.

Precision, Light and Heavy Machined Metal Products

The products included under this heading range from parts for stationary steam engines, excavating equipment, and industrial machinery to special mining equipment and parts for motor vehicles.[3] Most firms engage in more than one branch of engineering. Many of them originated as jobbing concerns catering for the mining industry but since 1945 have built large new workshops for the manufacture of precision equipment. Most important has been the growth in the manufacture of rock-drills and rock-drill spares. Before the war the output was around 1,000 tons annually, representing just over half the country's requirements. By 1945 it amounted to 1,500 tons and by 1950 exceeded 8,000 tons, which satisfied Union requirements and provided a surplus for export. In addition machinery, refrigeration and air-conditioning plants are now being made for the mines, high pressure steam boilers for power plants and the mines, tractors, harvesting machines, dairy equipment and water boring machines for agriculture, their manufacture being aided by the establishment of a heavy engineering corporation which is associated with Iscor and undertakes the very heavy work. The plain carbon steels and all the simpler ferrous and non-ferrous alloys are obtained from Union sources but certain special alloys and parts such as ball races, gauges, valves, and patented components have to be imported from overseas. The main centre of manufacture is naturally in the southern Transvaal, where with expanding mining, industrial, and agricultural markets, further development is likely.

Hollow-ware and Other Sheet Metal Products[3]

Unlike most of the engineering concerns, many of those making hollow-ware for the domestic market, and for the food canning industries are located at the coast; this preference is due partly to the fact that with the exception of galvanized and ordinary mild-steel sheets, all the basic raw materials – aluminium, brass, copper, stainless steel, and deep tinned sheets and strips – have, until recently, had to be imported, and partly to the large markets for domestic utensils in the Native Reserves and for food containers in the canning and jam factories of the south-western Cape and Port Elizabeth. In addition coastal sites are preferable for enamelling processes, the dusty atmosphere of the southern Transvaal, particularly in the environs of the mine-dumps, prejudicing the finish. The manufacture of hollow-ware was one of the earliest of the metal industries to be established, the advantages of proximity to the market for goods which are bulky in relation to weight and value offsetting the disadvantages associated with the need for importing the raw materials. Moreover, only comparatively simple machinery and unskilled labour are needed. Today there are around eighty concerns engaged in this type of manufacture, employing some 4,600 people of whom three-quarters are Non-Europeans. Some produce a variety of articles, others specialize in a few lines. The fabrication of tinned-food containers, which has increased fivefold since 1939 in response to the expanding market, is, in many cases, undertaken by the food-processing factories. While some of the articles produced by small concerns for the African trade are inferior, the greater part of the output, coming mainly from large factories established since the war, is of high quality. With the production of aluminium sheets and deep-drawing quality steel sheets and strips at Vanderbijl Park there is now a tendency for the manufacturers of domestic hollow-ware to favour sites in the southern Transvaal near the main Union market and well placed for export to the developing and potential markets of Central Africa.

The production of metal furniture and equipment is carried on by a number of small concerns on the Witwatersrand, but partly owing to shortages of suitable raw materials – particularly steel sheet of deep drawing quality – inadequate equipment and unsatisfactory buildings, much of the output has been of poor quality. The manufacture of hardware has laboured under similar difficulties. Recently, however, several modern factories have been built and with the production of an increased range of metals and sections by Iscor, the expansion of their trade may be expected.

The Mechanical Engineering Industries

Primary Products of the Engineering Industry

These include pipes, tubes, and foundry products, chains, wire ropes, and mechanical and structural fastenings. Their manufacture is concentrated in the southern Transvaal where proximity to Iscor iron and steel and to the mining market are important locational factors.

With an expanding market in agriculture, mining, and industry, the production of plain carbon-steel pipes and tubes, which constitute the bulk of the country's tubular steel requirements,[4] has advanced rapidly since 1939. During the war the output doubled. Since then expansion has continued and in particular, with the rolling of steel strip at the Vanderbijl steelworks, the production of welded conduits, for which strip had formerly to be imported, has increased. Today Union firms satisfy the bulk of the country's iron and steel pipe and tube requirements, the major output coming from three large and well-equipped factories. By contrast the output of non-ferrous pipes and tubes is small and production recent. Hitherto only lead pipes have been manufactured on any appreciable scale. In the absence of local supplies lead ingots are imported from Australia and pipe production undertaken at the port of import in the Cape. The production of copper tubes on a permanent basis (they were made at the Mint in Pretoria during the war as an emergency measure) began only in 1947, hitherto being discouraged by the small Union demand and by the fact that the arsenical copper specified for steam boiler applications had to be imported, all the African copper ores yielding non-arsenical copper. The copper hollows required in the manufacture of tubes are imported from England. Tube production is undertaken at the port of import in the Cape and also in Vereeniging where copper hollows are to be produced.

Whereas the production of pipes and tubes is concentrated in a few specialized modern factories, there are over one hundred establishments making iron foundry products and one hundred and forty-five equipped to make non-ferrous castings.[5] Steel foundry products, however, are made only by twelve firms. In the past castings required for repair or replacement purposes in the mining and manufacturing industries formed the bulk of the foundry business. Production was on a jobbing basis and since replacements were usually required urgently cost was a secondary consideration. Since 1939, however, a number of modern foundries specializing in the repetitive production of those castings for which there is a steady demand have been established, but the repair and replacement trade still supports numerous jobbing concerns. The total output of iron and steel castings has increased appreciably and the range of products considerably extended. Local pig iron, ferrous scrap, ferro-alloys, coke, fluxing agents, and moulding sands are used but wood and special metals for pattern making have to be imported. The manufacture of non-ferrous castings is hampered by the lack of local raw materials. Most of the metals used have to be imported, only non-arsenical copper and tin being available from local sources. Moreover because of the structure of the non-ferrous metals market and the fact that the whole cost schedule is based on London prices, the costs of even the virgin metals produced in the Union are higher for delivery in the country than for the same metals in Europe. Consequently appreciable quantities of the metals required are reclaimed from scrap. No refining is undertaken at foundries where suitable amounts of virgin and reclaimed metals are simply melted together to give the required com-

binations for castings. Because of this and because it caters mainly for the mining market the non-ferrous foundry trade, like the ferrous foundry trade, is located in the southern Transvaal.

In the production of chains and wire ropes used to render services where failure may cause loss of life, the quality of the raw material is of vital importance. The large mining market naturally encouraged the manufacture of these products but until the second world war the accepted raw materials – wrought iron rounds for chains and acid steel wire rods for wire ropes – had to be imported. The war-time demand for chains in all the belligerent countries exceeded the supply of wrought iron and low-carbon mild-steel had to be substituted. This was made in the Union. Likewise open-hearth basic steel was used for wire ropes. Since 1939 Union steel has been used both for chains and wire ropes, the output of which has risen greatly. In 1939 Union manufacturers supplied around 70 per cent of the chains and over 90 per cent of the wire ropes required in the country. Today, despite the greatly enlarged market associated with the development of new mines, they satisfy practically all the home needs and export wire ropes to the mining regions of Central Africa and Asia. The major output of chains comes from one large specialist firm in Vereeniging and that of wire ropes from two large factories on the Reef.

Hitherto the production of mechanical and structural assembly fastenings has been prejudiced by the lack of suitable raw materials, by poor equipment, and inefficient labour. The large-scale production of bolts, nuts, and rivets began in Vereeniging in 1934 and by 1939 the output exceeded 8 million lb., more than one-quarter of the national consumption. Production doubled during the war years and with the coming into operation of a large modern factory in Boksburg in 1945 it doubled again. Today three specialist factories account for most of the output which consists mainly of black bolts, nuts, and rivets. A beginning has, however, been made with bright steel products, nails, and split pins. Until recently the only local raw materials available were ordinary commercial steel rounds and consequently much of the output was not of the quality and dimensional accuracy required by the engineering industries. With the coming into production of a modern wire and rod plant at the Vanderbijl Park Steelworks, and with the introduction of new equipment in the post-war years, however, better quality products are now made. Altogether eleven firms are engaged in fastener production, nine of them being located on the Reef, one in Vereeniging, and one in Cape Town.

Heavy Structural Steelwork

Included in this category are mine headgears, bridges, building sections, conveyor systems, railway wagons, barges, and floating docks.* Ready access to raw materials is naturally a first consideration in locating works producing such bulky products but in some cases proximity to markets is more important. Structural engineering began in South Africa many years ago with the establishment of

small firms catering for the mining and building industries. Imported steel was used. After the completion of the Iscor steelworks at Pretoria the industry expanded in the face of strong overseas competition which necessitated efficient production. The second world war brought an extension in the range of products. Aircraft hangars, armoured cars, cranes, military bridges, barges, and floating docks were made while all types of marine craft, damaged by enemy action, were repaired. The experience thus gained was turned to good account after the war when among other things the production of railway wagons, hitherto largely imported, was undertaken. Whereas pre-war large tonnages of structural steel-work had to be imported, today most needs are met by the local industries. Altogether there are twenty firms engaged in heavy structural steelwork, twelve of them on the Reef and the rest in the coastal towns. Most make a wide and varied range of goods but the production of mining machinery is concentrated on the Rand; railway wagons are made both there and in Cape Town and Durban and light wagons for the sugar cane railways and machinery for the sugar industry in Durban.

The Electrical Engineering Industries[7, 8]

The electrical engineering industries are of most recent growth. In fact of the 150 firms engaged in them in 1950 only 29 existed before 1939 and 76 began production after 1945. Manufacturing in the real sense only began after 1939 when some of the old firms greatly extended and expanded their activities and new ones entered the field. Continued expansion after the war was greatly helped by the imposition of import control in 1948. By 1950 the electrical engineering industry employed nearly 11,000 people and the net value of its output approached £14 million. The value of electrical articles imported was about £20 million. The industry had become concentrated in the southern Transvaal, which contained over 70 per cent of the factories and accounted for more than three-quarters of the output. Port Elizabeth with an output valued at £2 million was second in importance with Cape Town and Durban lesser centres.

Certain sections of the electrical engineering industry have made more progress than others during the past twenty years, and all have shown some tendency to regional specialization, this being determined mainly by access to raw materials and markets. Most highly developed is the manufacture of electric wire and cable which is undertaken by seven firms, financially associated with overseas concerns; five are located in the southern Transvaal and the others in Port Elizabeth and Pietermaritzburg. One firm began the production of copper rod and wire in 1934 and another that of cables in 1938. The rest were established after 1946. Formerly when copper was imported from Canada a coastal situation was advantageous but today with electrolytic copper coming from the Katanga, copper rod and wire from Vereeniging, and galvanized wire from Vanderbijl Park, the southern Transvaal is most favoured. Other raw materials such as raw rubber, lead, p.v.c. compounds, and insulating paper are largely imported but being of light weight

exert little influence on industrial location. In 1950 the output of all types of cable and wire exceeded £5·6 million (£3·6 million insulated cable and wire and nearly £2 million non-insulated) and there was some export to the Far East, North Africa, and even northern Europe. It was still necessary, however, to import special cables and wire to the value of £2 million.

With an output valued at nearly £1 million in 1950 the manufacture of transformers, switchgear, and control gear, which began during the second world war, has developed very rapidly in response to the heavy market demands associated with the growth of mining and manufacturing and the provision of new power stations. The industry is concentrated on the Witwatersrand where a few large factories account for the bulk of the output. In 1950, however, the local industry was able to supply only 25 per cent of the country's transformer needs and high tension transformers valued at £1·5 million had to be imported. The home industry is handicapped by its dependence on overseas supplies of silicon steel, insulating paper and oil, and high-tension ceramic insulators, but steel sheet pipes, piping, and copper wire are available locally. The manufacture of generators and electric motors is more favoured, two-thirds by value of the raw materials required being available locally. Iscor, however, is able to provide only one-quarter of the motor grade silicon steel needed and enamelled wire, ball and roller bearings also have to be imported. In 1950, the industry, which is also concentrated on the Reef, provided motors to the value of nearly £½ million but imports exceeded £1·5 million and imports of dynamos and alternators approached £1 million.

By contrast the home production of primary and secondary batteries, while less valuable, provides over 90 per cent of home needs and supports a small export mainly to Central Africa. The industry is entirely dependent on imported materials. This together with the fact that the motor industry takes a large part of the output led to the initial establishment of the industry in Port Elizabeth. Since, however, secondary (accumulator) batteries, being classified as dangerous traffic bear a high rail freight, a location close to the market is advantageous and this branch of the industry is now found on the Witwatersrand and in all the main ports.

Since 1945 the manufacture of electrical domestic appliances and of lamps has become important on the Witwatersrand and in Port Elizabeth, the output of heating appliances, valued at over £1 million in 1950, meeting 75 per cent of the country's needs and that of electric lamps more than 50 per cent. Almost all the raw materials and parts have to be imported and this together with the availability of female Coloured labour (nimble fingers being important) and its relative centrality with regard to the main markets, has led to the growth of the industry in Port Elizabeth.

Other branches of the electrical engineering industry are, as yet, little developed, although a start has been made in the assembly and manufacture of telephones and radio transmitting and receiving equipment.

The Vehicle Industry

In 1947, with nearly half a million registrations, South Africa was the seventh largest user of motor vehicles in the world, being exceeded by the U.S.A., the U.S.S.R., the U.K., Canada, France, and Australia. Only five countries had a lower average of persons per vehicle and only the U.S.A. had a lower average of Europeans per vehicle. In South Africa the vast distances and generally sparse population spread make a motor-car a necessity rather than a luxury, while over much of the country railway motor bus services (see p. 494) linking remote areas with the railhead provide the only regular means of transport for both passengers and mails. With a large market to cater for and heavy maintenance consequent on generally rough road conditions (see p. 493) it is not surprising that both in terms of employment and value of output the vehicle industry occupied a place among the major groups of industries.

The South African motor industry, however, has developed only under the cloak of tariff protection and even today is concerned essentially with the assembly of vehicles imported in a completely knocked down condition; apart from bus body building little actual manufacturing is undertaken. This position is due partly to the powerful hold of overseas motor firms and partly to the fact that the motor industry is one run on mass production lines and draws many of its parts from a great variety of other industries. It can be successfully developed only in highly industrialized countries with opportunities for reaching a large market. South Africa is only approaching this position today.

The South African motor industry is a natural outgrowth of the earlier cart and wagon industry which reached quite large dimensions after the opening of the diamond and goldfields. This industry was carried on mainly in the ports, the starting points for the traffic to the interior. Here timber was available from the indigenous forests, a body of skilled workers grew up and when the cart and wagon trade declined with the replacement of animal drawn vehicles by motor vehicles, unemployment resulted. To remedy this the Government took steps to promote the development of a local body building and motor assembly industry.[9] High duties – up to 25 per cent – were levied on imported motor-cars whereas, after 1925, the duties on chassis for bodies to be built in the Union were reduced to a low level. This policy was carried a stage further in 1934, when, in order to encourage the motor assembly industry, the duties on body parts and materials were reduced.

The motor-car assembly industry began with the establishment of assembly plants by the Ford Motor Company in 1924 and General Motors Ltd in 1926. In both cases development was motivated by the desire to overcome tariff obstacles, secure the advantages of lower freight charges and lower labour costs and permit the adaptation of the product to local demand. Both concerns chose Port Elizabeth as the centre for their plants, mainly because it is most conveniently situated for the distribution of assembled vehicles. Subsequently South African firms began the assembly of other American and some British cars at Uitenhage, Cape Town,

and Natalspruit, near Johannesburg, and after the second world war Nash Motors Corporation erected an assembly plant at East London, the British Motor Corporation one at Cape Town, and a South African firm one at Durban. The expansion in the post-war period has been occasioned very largely by the increase in freight rates, particularly ocean freight rates, while the assembly of British cars has been stimulated by tariff preference and by the greater demand for small cars for city use consequent on urbanization. Today the assembly industry is capable of turning out 83,000 cars per annum, which is about 30,000 cars in excess of the normal yearly demand in the Union, but during the past few years a small but increasing export trade to the Central African countries has developed, in 1950 bringing in nearly £3 million.

The assembly plants show a marked preference for port locations and particularly the Port Elizabeth – Uitenhage area where a number of ancillary industries have grown up, notably the making of tyres and upholstery. The advantages of proximity to the market, however, have led to the erection of two assembly plants at Natalspruit, while access to the market and to the iron and steel works has encouraged a Swiss firm making cheap cars to select Pretoria for its factory. The British Motor Corporation intends later to manufacture cars from South African materials and as this trend develops the industry will probably shift to the Transvaal.

By contrast with the motor-car industry the bus, truck, and van building industry involves manufacture in the fullest sense of the term. This difference is due largely to the fact that while engines and chassis have to be imported, the bodies of buses, trucks, and vans are built to meet the requirements of the individual transport operators. Bus, truck, and van building began soon after 1925, when chassis were admitted at 5 per cent duty. Four years later the industry received further encouragement by the reduction of the duty on completely unassembled chassis to 3 per cent. At this time the bodies were built of composite materials – mainly steel panels fixed to a wooden framework. Soon after, however, the construction of all-metal bodies, offering greater durability and lower weight, was developed overseas and it became necessary for the local manufacturers to import the various sections and parts which were admitted under rebate of duty. The building of all-metal bodies in the Union, however, made little headway and because the bus services catered mainly for the lower income section of the population, the Government in 1936 decided to import all-metal buses, assembled or unassembled, at a duty of 5 per cent. This stifled the local industry until the second world war when the building of all-metal bodies, for which home produced steel was now available, was undertaken. Thereafter the increase in sea freight, landing charges, and railage gave the local manufacturers sufficient protection against the import of buses fully assembled overseas. The local industry, however, was threatened by the erection of assembly plants by overseas manufacturers, to counter which the Government imposed a 20 per cent duty on unassembled motor buses in 1947.

The location of the bus building industry differs from that of the motor-car assembly industry partly because it is concerned with actual manufacture and partly because its market is more concentrated. The main users of motor buses are the municipal operators in the major towns and the South African Railways. The largest market is on the Rand where nine of the sixteen urban operators are situated. Partly to enjoy proximity to this market and partly because most of the raw materials used in the industry are produced there, the bus building plants are concentrated on the Rand. Here the South African Railways established their works at Kazerne (Johannesburg) in 1933 and B.M.S. Limited in Johannesburg in 1936. The latter firm linked up with the Park Royal Coachworks of Great Britain in 1945. In the same year another large works came into operation in Industria. About 20 per cent of the materials used by these works are of local origin. The one bus assembly plant which was established just after the war however, is located in Port Elizabeth.

The bus building companies also make trucks and vans while the former are also assembled by the motor-car firms.

BIBLIOGRAPHY

1. B.O.T. Report No. 311. 'Investigations into the Iron, Steel, Engineering, and Metallurgical Industries of the Union of South Africa'. Pt 4. 'Heavy Structural Steelwork and Light Fabricated Metal Products', *Supp. Comm. and Ind.*, Vol. VIII, No. 7, Mar. 1950, p. 276.
2. B.O.T. Report No. 311. 'Investigations into the Iron, Steel, Engineering, and Metallurgical Industries of the Union of South Africa'. Pt 5. 'Precision, Light and Heavy Machined Products'. *Supp. Comm. and Ind.*, Vol. VIII, No. 10, June 1950, pp. 495–504.
3. B.O.T. Report No. 311. 'Investigations into the Iron, Steel, Engineering, and Metallurgical Industries of the Union of South Africa'. Pt 3. 'Sheet Metal Furniture and Equipment, Sheet Metal Hollow-ware and Hardware'. *Supp. Comm. and Ind.*, Vol. VIII, No. 2, Oct. 1949.
4. B.O.T. Report No. 311. 'Investigations into the Iron, Steel, Engineering, and Metallurgical Industries of the Union of South Africa'. Pt 1. *Supp. Comm. and Ind.*, Vol. VII, No. 6, 1949, pp. 311–28.
5. B.O.T. Report No. 311. 'Investigations into the Iron, Steel, Engineering, and Metallurgical Industries of the Union of South Africa'. Pt 3. 'Foundry Products'. *Supp. Comm. and Ind.*, Vol. VII, No. 10, June 1949.
6. B.O.T. Report No. 311. 'Investigations into the Iron, Steel, Engineering, and Metallurgical Industries of the Union of South Africa'. Pt 4. 'Heavy Structural Steelwork and Light Fabricated Metal Products'. *Supp. Comm. and Ind.*, Vol. VIII, No. 7, Mar. 1950.

7. B.O.T. Report No. 332. 'The Electrical Goods Manufacturing Industry'. Pt 1. *Supp. Comm. and Ind.*, Vol. xi, No. 4, Dec. 1952.
8. B.O.T. Report No. 332. 'The Electrical Goods Manufacturing Industry'. Pt 2. *Supp. Comm. and Ind.*, Vol. xi, No. 5, Jan. 1953.
9. B.O.T. Report No. 313. 'The Motor Industry'. *Supp. Comm. and Ind.*, Vol. vii, No. 12, Aug. 1949, pp. 705–64.

27

The Food Industries

Both as regards employment and net value of output the food industries are second in importance to the metal-working and engineering industries. They are concerned essentially with the processing of the produce of South African agriculture and most of them have already been considered in the relevant agricultural chapters. Only a brief summary dealing mainly with their geographical distribution will be given here.

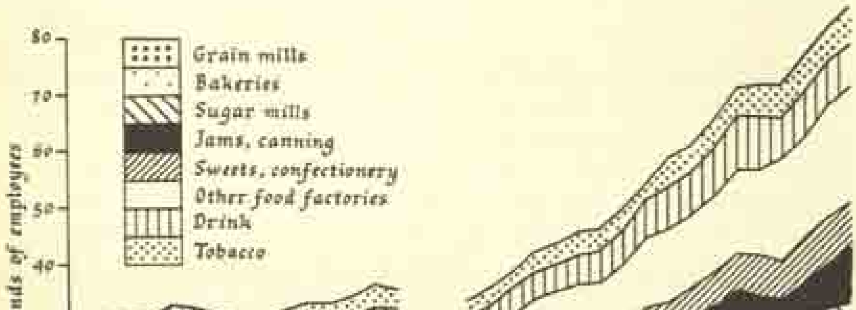


Fig. 157. The number of employees engaged in the various branches of the food industries of the Union of South Africa, 1915-50.

The food-processing industries were among the first industries to become established in South Africa and, although no longer the most important in terms of employment and net value of output, they have nevertheless shown a striking

growth during the present century. Some of them, like grain milling, bread, and biscuit manufacture (see Figs. 157 and 158), have expanded to meet the needs of the increasing urban population; others, notably meat processing and butter and cheese production (see Fig. 159), have kept pace with rising agricultural output. By contrast, the canning and jam-making industries (see Fig. 160) grew rapidly during the second world war when the loss of export markets for dessert fruit was offset by an enormous demand for preserved fruits and vegetables for the Allied forces. The accelerated expansion of these industries since 1945 has been assured by the excellent reputation acquired by their products in overseas markets in the immediate post-war years.

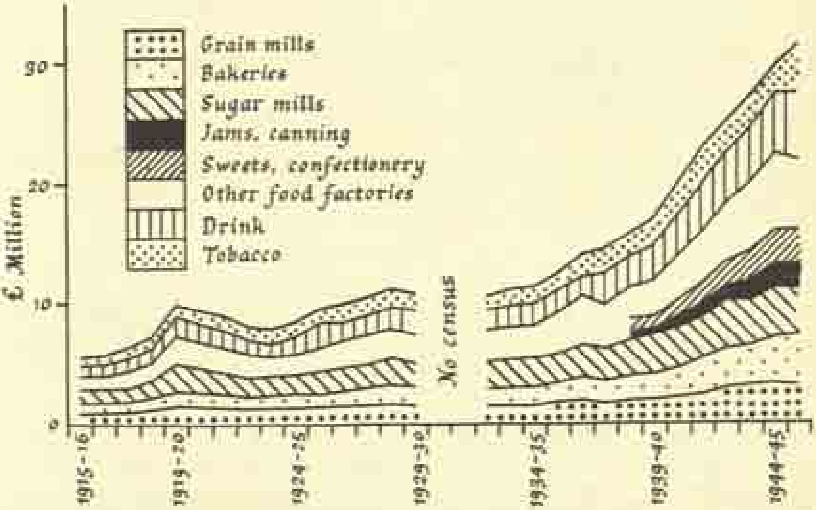


Fig. 158. The net output of the various branches of the food industries of the Union of South Africa, 1915–50.

The location of the food-processing industries depends on the keeping qualities and on the bulkiness of both the raw materials and the processed foodstuffs. The fruit and vegetable canning factories require fresh produce and hence are located in the growing areas. Four areas are outstanding – the south-western Cape which handles mainly deciduous fruits, Port Elizabeth and East London which preserve pineapples and citrus fruits, the Transvaal Lowveld preparing vegetables, and the Witwatersrand concerned with vegetable processing and pickle manufacture. The butter and cheese factories are found in the inaccessible surplus milk-producing areas, especially in the eastern Free State and northern Cape (see Fig. 87). The meat packing plants are on the Witwatersrand and in Estcourt which is centrally situated relative to the cattle and pig rearing areas. The sugar cane mills are distributed within the cane belt (Fig. 65). The grain mills are located at natural collecting centres astride the railways in the

maize-producing area and in the major ports, where imported wheat is milled. By contrast the bakeries must be near the consuming market and hence are widely dispersed in all the major towns of the country. The manufacture of biscuits and confectionery, however, depending on a variety of raw materials, but notably sugar, flour, and cocoa, is carried on mainly on the Witwatersrand and in the ports where the best facilities for the assembly of raw materials and despatch of finished products obtain.

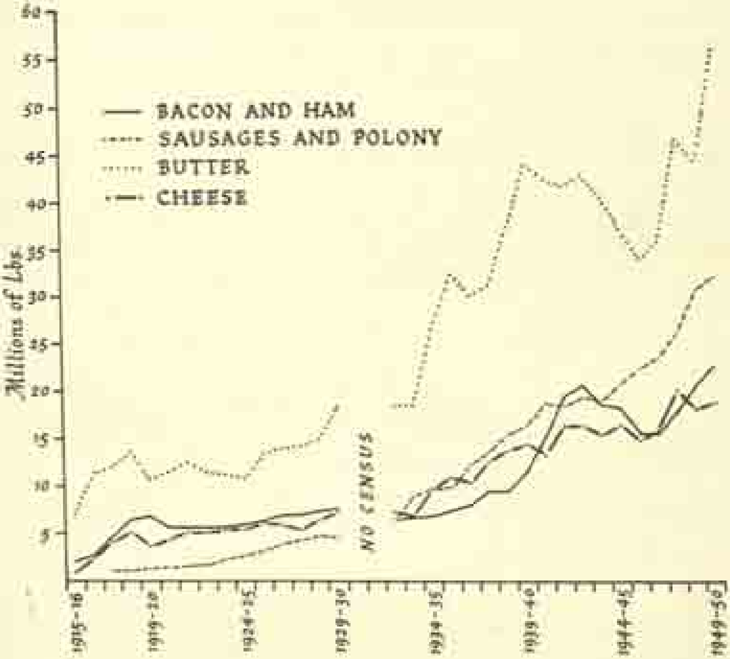


Fig. 159. The output of processed pastoral food products, Union of South Africa, 1915–50.

The most important drink industries are the making of wine and of beer but, with fruit juices readily available and a hot climate creating a large market for soft drinks, large and increasing quantities of squashes, cordials, and aerated minerals are produced. Wine making is centred on Paarl and Stellenbosch in the south-western Cape (see pp. 213, 511). The breweries, using mainly home-grown barley and imported hops are concentrated where suitable water is to be found in the main market centres in the ports and on the Witwatersrand. On the Reef excellent borehole water from the Witwatersrand rocks is responsible for the concentration east of Johannesburg. Squashes and cordials are produced as a sideline in the fruit canning factories particularly in the Transvaal Lowveld, the main citrus area.

The food industries make an important contribution to the export trade of South Africa. Most important are the canning and jam making industries which in 1955 exported 60 per cent of all their canned products, 80 per cent of their canned fruit, and 30 per cent of their jam and marmalade output. This was sent

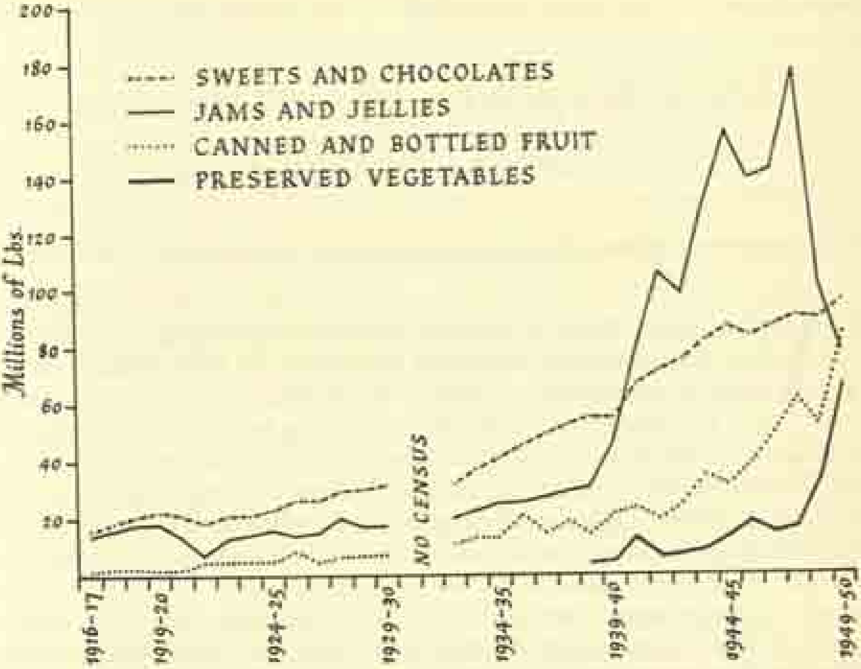


Fig. 160. The output of processed fruits and vegetables and of confectionery, Union of South Africa, 1915–50.

mainly to the U.K. bringing in £7 million, but trade with the U.S.A. is increasing. The wine export is also important while small quantities of butter, cheese, and canned meats are sent overseas. In recent years too there has been a tendency for more of the maize crop to be exported in processed form.

28

The Fibre-processing, Textile, and Clothing Industries

Although South Africa is the sixth largest wool-producing country in the world and grows some cotton and other fibres, her textile industry, apart from the manufacture of blankets and knitted goods, dates only from 1946.[1] This late development is the more surprising because, judged from the experience of Europe and America, and more recently Japan, India, and Brazil, the textile industry is usually one of the first-comers when a predominantly agricultural country begins to industrialize.[2] It is explained very largely by the fact that the period of industrial growth in South Africa – from 1918 onwards – was one of acute depression in the world textile industry, with capacity far in excess of market needs. During this intensely competitive period no country could develop a textile industry without tariff protection, while those countries with low wage rates enjoyed a considerable advantage. The South African labour force then consisted largely of Europeans, commanding high wages, and even when Coloured people and Africans were employed they received higher wages than workers in India and Japan. Moreover the clothing industry, offering more highly skilled employment, was being encouraged and the free import of overseas textiles was essential for its growth. Hence only the manufacture of blankets and certain hosiery goods was accorded tariff protection.

At the end of the war in 1945 the position had changed to one of an acute shortage of textiles the world over. Manufacturers in Europe, particularly in Britain, found expansion at home hampered by shortages of power and labour, while fiscal and political considerations encouraged them to develop factories in overseas countries, including South Africa. The fact that the Union textile market, then one of the largest low-tariff markets left in the world, could not be expected to remain so indefinitely, was a further incentive. Between 1945 and 1954, 37 textile factories were established, most of them by subsidiaries of overseas firms and mostly financed by foreign capital. Of the rest some, e.g. the Good Hope factory at Zwelitsha (Kingwilliamstown) in the Ciskei and the Fine Wool

Products factory at Uitenhage, were largely financed by the Industrial Development Corporation. Eleven of the factories work up a range of fibres, 15 are concerned with wool, and 11 with vegetable fibres, mainly cotton.

The Union textile industry at present supplies only about 20 per cent of home needs. Its expansion depends partly on its ability to compete with overseas suppliers, and partly on the tariff policy followed. Since 1951, with the recovery of the industry in Western Europe and Japan, there has again been a surplus of textiles. While the South African industry enjoys the advantage of modern machinery, its ability to compete is hampered by its high wage structure, the low productivity per operative (caused by the rapid turnover of labour, see p. 404), and the fact that industrial legislation limits the employment of females to day-time shifts. Further development is therefore unlikely without tariff protection.

The Wool Textile Industry

In 1954 there were 66 factories using wool as their principal raw material.[a] Between them they dealt with all the processes from the raw wool to the finished cloth. Basically there are five major processes – scouring, combing, spinning, weaving, and finishing – and six kinds of wool textile manufacture – worsted cloth, woollen cloth, blankets, knitted cloth, felting, and carpets.

The raw wool must first be scoured in a soap solution in order to remove its natural grease; after oiling, the wool is then passed through scribbling and carding machinery so that thin ropes of roughly parallel fibres are produced. These may be spun directly into yarn for the woollen industry or combed and then spun into yarn for the worsted industry. The yarn is either woven into cloth or used for knitting. Woollen cloth is then shrunk and felted in order to conceal the weave, while worsted cloth, in which it is desired to show up the weave, is steamed and pressed. Apart from the necessity for combing prior to spinning, the actual spinning of worsted yarn requires more processes than the spinning of woollen yarn, while generally speaking the various processes in the manufacture of worsted goods are of a more complex nature. The raw materials used in the several branches of the wool textile industry also differ. Thus the worsted industry uses mainly long wool, the woollen industry wools which are too short for combing, and the carpet industry the poorest harsh wools.

The several processes and the various branches of wool textile manufacture are sometimes carried on in specialist establishments and sometimes in integrated factories. Thus of the 66 wool textile factories, 35 are engaged in scouring, combing, spinning, and weaving operations, 24 are knitting works, 4 are felting establishments, and 3 make carpets and rugs. Of the 35 factories in the first category some are concerned with one process while others carry on two or more (Fig. 161). Only 15 are engaged in both spinning and weaving and 12 of these are blanket factories. While some factories specialize in one branch of manufacture, others produce a range of goods, including, in some cases, cotton and rayon textiles as well.

In 1954 the industry provided employment for nearly 12,000 people, of whom 1,500 were Europeans, nearly 4,000 Coloureds, and the remainder Africans. More than half of them were engaged in blanket manufacture. Unlike the position in other parts of the world the labour force was very largely male. Associated with this the labour turnover, at about 18 per cent, was very high and prejudiced the acquisition of skill. Largely because of this, efficiency is below that in the older textile-producing countries where employment in the industry has become a tradition in families.

The Wool-scouring and Carbonizing Industry

The average weight of scoured wool is only about one-half that of grease wool, yet despite the saving in freight charges that could be effected by the export of scoured wool, the bulk of South Africa's wool clip is exported in the grease. This is because overseas buyers prefer to import grease wool since the success of

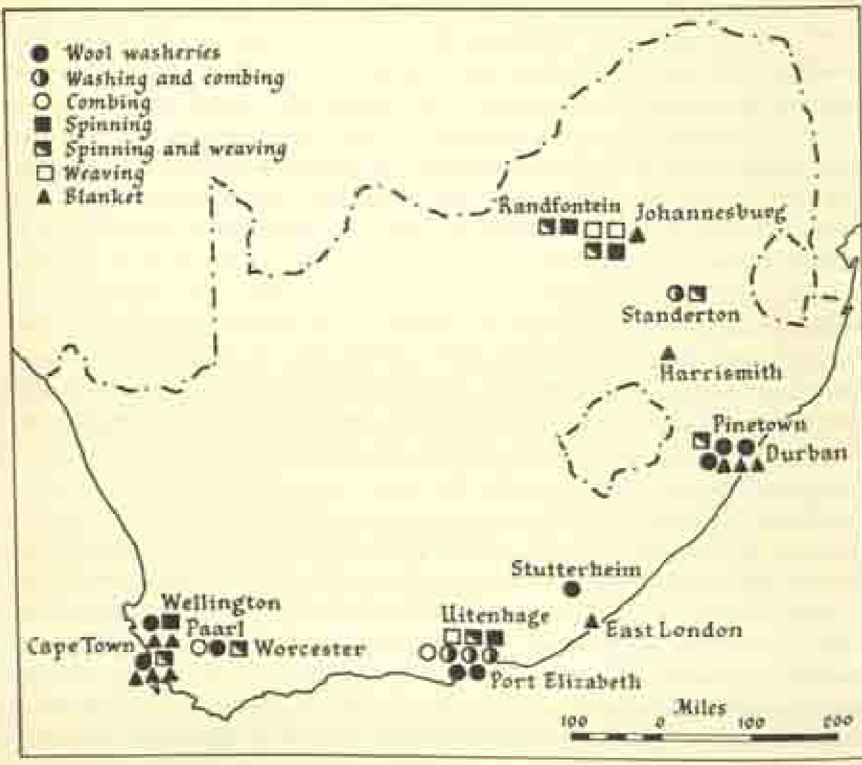


Fig. 161. The distribution of woollen textile factories in the Union of South Africa.

Each symbol represents one factory. (After G. E. Roberts, courtesy of *Commerce and Industry*.)

woollen and worsted manufacture depends very largely on the blending of various types of wool whose quality is most easily judged in the raw state.

Wool scouring began at an early date at Harrismith and Caledon river where ample supplies of soft water were available and in 1850 the first wool washery was established at Swartkops river near Uitenhage. Before the first world war, however, the amount of wool washed at home was very small. During the war the shortage of shipping space and less attention to quality in the overseas woollen industry led to increased wool scouring in South Africa. By 1919–20 the wool washeries employed about 150 people and produced over 18 million lb. of scoured wool. Subsequently, however, activities declined and by 1939 the output was only about 8 million lb. Again the war-time shortages of shipping space necessitated increased wool scouring at home and with additional capacity the output rose to 23 million lb. by 1945. The subsequent development of the Union textile industry encouraged further increases and in 1949–50 a peak of 28¼ million lb. of scoured wool from 60 million lb. of grease wool was achieved. Since then there has been a slight decline. At present wool scouring is carried on in 15 factories; in 9 of them it is the only operation performed. These factories are equipped to wash 100 million lb. of wool annually but because of the smallness of the South African wool textile industry and of the preference of overseas buyers for grease wool, a large part of the capacity is not utilized. As it is, the bulk of the scoured wool – around 20 million lb. – is exported. The washeries are within the wool-producing areas (Fig. 161) – their absence from the Witwatersrand being notable – and are located either in large towns where they draw on municipal supplies for their water or near important rivers carrying soft water. The concentration in Port Elizabeth is associated with its historic function as market and export port for the bulk of the country's wool clip. In addition to local wool, the washeries also scour imported cross-bred wool used for blending in the Union's woollen and worsted factories. Three of them are equipped for the recovery of wool grease which is used in the manufacture of soaps, cosmetics, pharmaceuticals, and lubricants.

The Wool-combing Industry

The wool-combing industry, which dates from 1948, comprises six establishments of which four work on a commission basis and two form part of integrated textile factories. Four of them are located in Port Elizabeth where they enjoy proximity to the wool brokers. Both home-produced merino and imported cross-bred wools are combed in order to provide a variety of tops. In 1953 the industry combed nearly 10 million lb. of scoured wool of which nearly 1¾ million lb. was imported wool. The production of tops amounted to over 8½ million lb. of which less than 3 million lb. could be absorbed by the local worsted industry. The remainder was exported mainly to the United Kingdom, Belgium, and Japan. The 1953 output was well below the maximum production capacity of existing plants which amounts to 18 million lb. tops on a two-shift system or 25 million lb. tops on a

three-shift system. The latter output would account for 50 million lb. grease wool, equal to 28 per cent of the Union's annual wool clip. The expansion of wool combing, however, depends on the export market, and while local production costs are equivalent to those in Britain and slightly less than those on the Continent of Europe, freight charges tip the balance in favour of the European combers.

The Woollen and Worsted Industries

Although the woollen and worsted industries date only from 1946, they already provide a large part of the Union's requirements. While two factories engaged in the worsted industry confine their activities to spinning and two others to weaving, a feature of the industry is the integrated nature of the establishments, most of which spin and weave both worsted and woollen cloth. In 1954 there were altogether ten factories engaged in worsted production and four in woollen production. In addition some of the blanket factories undertook the spinning of woollen yarn on commission while two of them made woollen tweeds as well. Despite its more complex nature the worsted industry has developed much more rapidly than the woollen industry, mainly because it uses fine merino wool, large supplies of which are available locally. Today it possesses 22,600 spindles and 316 looms whereas the woollen industry has only 4,968 spindles and 80 looms.

The location of the worsted and woollen industries contrasts significantly with that of the wool washing and combing industries, being centred particularly in the southern Transvaal, with Port Elizabeth second in importance. The raw material – scoured wool – is of lighter weight and higher value than grease wool, and for these industries the attraction of the market, very largely the clothing industry, is a more potent locational factor than proximity to the source of raw material.

In 1954 the worsted and woollen spinning industry comprised ten establishments of which eight produced yarn throughout 1953. In that year the production of worsted yarn amounted to about 2¾ million lb. about equally divided between knitting yarn and weaving yarn. Most of the output was absorbed by local industries which had to import less than 1 million lb. The remainder was sold as hand-knitting yarn. The production of woollen yarn was only about ½ million lb. and more than 2 million lb. had to be imported. At present there are ten weaving establishments, four of which are engaged in worsted manufacture, three in the production of woollen piece goods, and three in both branches. A range of materials is produced – suiting, hopsack, worsted flannel, serge, blazer cloth, woollen tweed, woollen scarves, etc. In 1953, when five factories were in production, the output of worsted cloth exceeded 3 million square yards. In the same year 4 million square yards were imported, but the local industry was able to hold its own. By contrast the output of woollen goods was small and suffered from strong overseas competition. It is difficult to accord protection to these industries because they do not yet provide an adequate range of goods, and duties on the

imported articles would seriously affect the clothing industry. Future expansion depends on the ability of the local industry to compete with overseas producers and here the worsted industry, which utilizes the local high-quality merino wool, is the more favoured.

The Blanket Industry

The early development of blanket manufacture was due very largely to the fact that it supplied directly a consumer market and could therefore be accorded protection, for its raw materials are mainly imported. The first factory was established in Kingwilliamstown in 1900 and was followed by others, established either in the inter-war years or after 1945, mainly in Durban, Cape Town, and Paarl. Today there are 15 factories of which 12 manufacture woollen and woollen-mixture blankets and the remainder cotton blankets. The factories have an installed capacity of 24,000 spindles and 1,462 looms. The absence of blanket manufacture from Port Elizabeth is notable but the industry uses very little of the fine merino wool handled in this town. Instead it uses mainly cross-bred wool imported from Australia, New Zealand, and South America. In 1953 it absorbed over 4 million lb. of imported scoured wool and only 2½ million lb. of locally scoured wool, of which 25 per cent was derived from karakul sheep. In addition it used over 5 million lb. of old and recovered wool.

Such has been the expansion in the blanket industry since 1938–9 that the output has risen from 1 million to between 4 and 5 million blankets annually. This virtually satisfies the country's requirements and very few blankets are now imported.

Other Wool Industries

These comprise the knitting, felting, and carpet industries. The 24 knitting establishments produce mainly socks, stockings, and piece goods in the manufacture of which cotton and rayon are also used. Four factories make felt goods – men's hats on the Rand and slippers in Durban, Port Elizabeth, and Cape Town – while carpets are made in Cape Town and Durban.

The Cotton Textile Industry

Although the Union is only a minor producer of cotton and other vegetable fibres, the cotton textile industry is relatively bigger than the woollen textile industry. This is due largely to the fact that its development was encouraged in order to meet the needs of specific local markets – lining fabric for the rubber tyre industry, cotton and jute bags for wool and sugar, hessian pockets for citrus fruits and potatoes, etc. Despite its recent establishment certain locational trends are discernible.

Unlike the Lancashire cotton industry both spinning and weaving are undertaken in the same centres while three-fifths of the spindles – 63,692 out of 106,756 – and nearly all the looms – 1,144 out of 1,800 – are installed in six

vertically integrated factories, the first of which came into operation only in 1947.[4] In addition there are two other spinning mills and thirteen very small weaving establishments, as well as six factories manufacturing cotton blankets, five producing cottonwool, three making chenille and various other small mills producing elastic, woven labels, etc. The integrated mills concentrate on the production of relatively few types of material, two specializing in materials for industrial

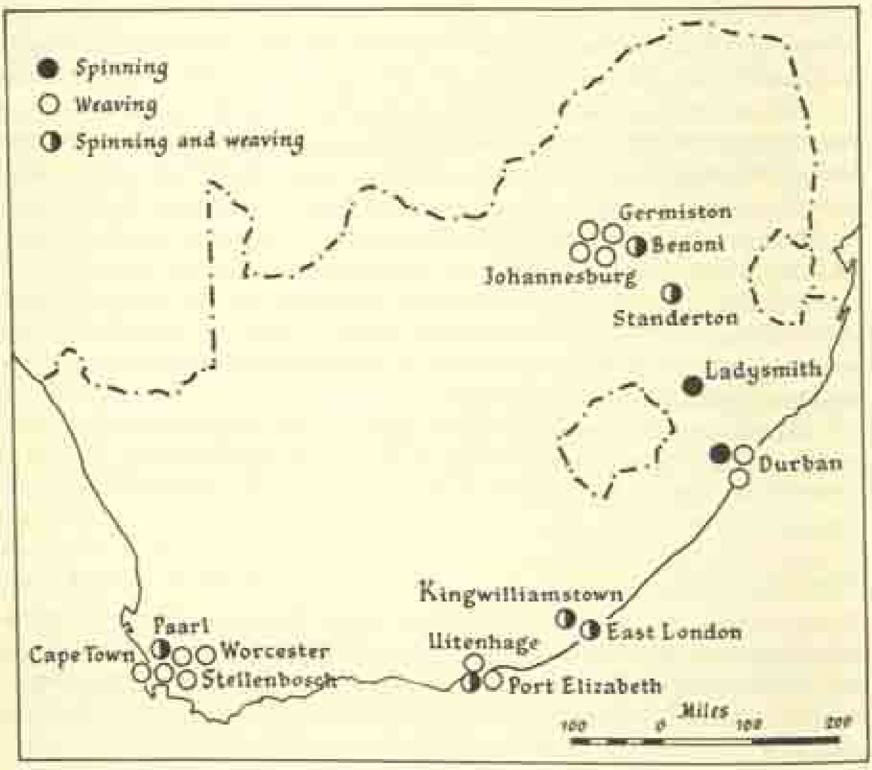


Fig. 162. The distribution of cotton textile factories in the Union of South Africa. Each symbol represents one factory. (After F. Burger, courtesy of *Commerce and Industry*.)

purposes such as tyre cord, tyre fabric, and chafer material for the rubber industry, while three manufacture calico, drill, twill, and sateen.[5] The thirteen weaving establishments are also specialized but make only simple fabrics such as canvas, towelling, and furnishing. As yet no mill is equipped to make printed cloth, but one, in Cape Town, produces 'sanforized' materials. The integrated nature of the industry is primarily a result of its youth and if and as the industry expands the separation of spinning and weaving may be expected with each section specializing in the production of a range of goods.

The location of the existing mills (Fig. 162) has been determined very largely

by proximity to the market, this being particularly true of the factories in the Port Elizabeth–Uitenhage area which supply the local tyre industry and in the Cape Western industrial area. Elsewhere access to home-produced raw cotton and 'stokroos' (see ch. 11) has been a factor favouring the Rand, Ladysmith, and Durban–Pinetown.

The Clothing Industry[8]

While the making of clothes by handicraft tailors and dressmakers has been carried on in South Africa for a very long time, the manufacture of ready-made garments in large factories is comparatively recent. This late development has been due mainly to the fact that perhaps more than any other industry the manufacture of ready-made garments has suffered from the smallness of the home market which has limited the mass production of a sufficiently wide range of sizes and styles. Moreover the industry has been further handicapped by its dependence on overseas suppliers for all its raw materials. Until 1946 this dependence was total; even now local factories provide only a limited range of cloth.

As in most countries the location of the clothing industry has been influenced mainly by the proximity to the consuming market. Cheapness of assembly of raw materials and the availability of suitable labour have been secondary but nevertheless important considerations.

Naturally the dressmaking and tailoring trade first developed in Cape Town which until the end of the nineteenth century was the only important population centre in Southern Africa. Imported cloth was used and Coloured labour employed. With the development of the goldfields the main market shifted to the Witwatersrand where a similar trade developed. But the advantages of a port location for the import of cloth and the availability of skilled Coloured labour led to the selection of Cape Town as the site for the first factories erected at the beginning of this century. Subsequently factories were established on the Rand but they had to depend on highly paid European labour and were further handicapped by the high railway freight on imported cloth. Cape Town retained its lead until 1928 but the industry in the country as a whole remained small, employing only about 11,000 workers. It was largely confined to bespoke tailoring and the production of factory bespoke clothes. By 1930, however, the bespoke factories could no longer compete with the greatly improved ready-made clothing produced in the United States and the United Kingdom. Aided by the imposition of high duties on imported clothing,* however, several factories started the manufacture of ready-made clothing in South Africa, concentrating on those articles for which the demand was greatest and perfection of fit not of paramount importance. Most successful was the manufacture of shirts and pyjamas carried on mainly in Cape Town, the output increasing sixfold between 1929–30 and 1938–9. In the latter year 12 million shirts were produced – an average of two for every male person in the country. By 1939 trousers and sports jackets were

* In 1925 these were increased from 25 to 35 per cent *ad valorem*.

satisfactorily made but the few suits that were made were of inferior grade. Little progress was made in the manufacture of ladies' fashion garments partly because of the 'dumping'* of end-of-season frocks by countries situated in the northern hemisphere, mainly the U.S.A. By 1939 employment in the clothing industry had risen to 22,000 persons, the bespoke trade had declined, and the manufacture of ready-made clothing had been successfully started. However, partly because of less efficient organization and partly because of the relatively high wages (compared with overseas countries) commanded by the European operatives who constituted nearly two-thirds of the labour force, Union manufacturers could compete only in a limited range of articles.

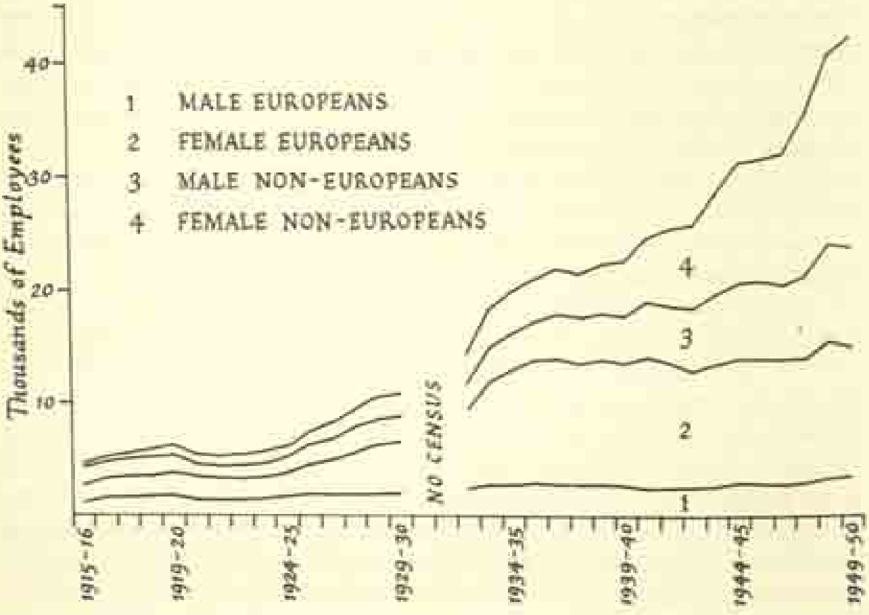


Fig. 163. The labour force of the clothing industry in the Union of South Africa, 1915-50.

The protection afforded by the second world war gave the South African clothing manufacturers their chance. So rapidly did the industry expand that by 1945 it employed over 31,000 people (Fig. 163). Most progress was made in the manufacture of women's outer garments, employment in this section increasing by 435 per cent, representing 76 per cent of the overall increase in employment in the clothing industry. The value of the output increased eightfold – from just over £½ million in 1938–9 to over £4 million in 1944–5.† Attention was devoted

* The term 'dumping' refers to the selling on overseas markets of goods at less than their cost of manufacture.

† The general increase in prices, should, however, be borne in mind.

mainly to the production of cotton frocks, for which, by virtue of a warm sunny climate there is a large market both in South Africa and the neighbouring Rhodesias. Most branches of the clothing industry, however, expanded and such was the improvement in quality that, in the production of high-grade garments, Union manufacturers were able to compete with American and European producers in the post-war years.

This new-found ability of Union clothing manufacturers to compete with overseas producers is due essentially to the introduction of mass production methods which, by sectionalizing all the operations in the factories, permitted the employment of unskilled or semi-skilled Africans. Between 1939 and 1949 there was little change in the number of European employees but the number of Non-Europeans increased by nearly 200 per cent (Fig. 163). By 1949 they constituted more than two-thirds of the labour force, a reversal of the 1939 ratio. This change in the labour structure brought down the cost of production at a time when wages were rising overseas. Today there is little difference in the average wage in the clothing industries of the United Kingdom and South Africa, although there is a much wider difference in wage between the highest paid and the lowest paid worker in the latter country.

With the development of ready-made clothing manufacture and the entry of the Africans into the ranks of its employees, the hub of the industry has shifted to the southern Transvaal which is not only the biggest individual market but also is most conveniently located for distribution to markets in other parts of the country and in the Rhodesias. At the same time the industry has developed in Durban and Port Elizabeth. Thus today the clothing industry is concentrated on the Witwatersrand and in Cape Town with Durban and Port Elizabeth as secondary but nevertheless important centres. In each proximity to the market has been the main locational factor, the size of the industry in each centre being roughly proportionate to the population. The cheapness of assembling raw materials has also been important in the coastal centres. Specialization has been influenced both by nature of the market and the composition of the labour force. Thus trouser manufacture which employs mainly skilled Europeans for cutting and unskilled male Africans for machining and pressing is centred in Johannesburg; dresses are made principally in Cape Town and Johannesburg, the main fashion centres; shirts, pyjamas, and men's underwear in Cape Town, where female Coloured workers are largely employed; shirts also in Durban and knitted goods in Johannesburg.

Today the clothing industry produces a wide range of articles. In some lines it satisfies the home market and has a small but growing export trade. In others – notably the manufacture of juvenile clothes, a very specialized trade, and the production of very cheap cotton frocks – it cannot compete. The manufacture of ladies' hosiery has been slow to develop, mainly because of the small home market and the necessity for very costly machinery but since 1951 nylon stocking factories have been established in East London, Cape Town, and Parys.

BIBLIOGRAPHY

1. F. J. C. CRONJE. 'The textile industry in the Union of South Africa'. *S.A.J. Econ.*, Vol. XX, No. 1, 1952, pp. 23–30.
2. *The World Textile Industry*. International Labour Office Publication. Geneva. 1937.
3. G. E. ROBERTS. 'The South African wool industry'. *Comm. and Ind.*, Vol. XIII, No. 7, 1955, pp. 331–7.
4. F. BURGER. 'The cotton industry in the Union of South Africa'. *Comm. and Ind.*, Vol. XII, No. 7, 1954, pp. 341–56.
5. See F. COLE. 'The textile industry in the Union of South Africa'. *Comm. and Ind.*, Vol. XV, No. 2, 1956, pp. 109–24.
6. B.O.T. Report No. 303. 'The clothing industry', *Suppl. Comm. and Ind.*, Vol. VI, No. 9, 1948.

29

The Tanning, Footwear, and Leather Industries

As one might expect, in view of the traditional importance of cattle and sheep rearing, the manufacture of leather and leather articles ranks among the oldest industries in South Africa. Tanning and the manufacture of boots and shoes began soon after the first European settlement in the Cape but after a long period of slow and chequered growth they became firmly established only under the natural protection from overseas competition afforded by two world wars and the artificial protection created by import duties on overseas products. Perhaps more than any other South African industry their growth reflects the importance of changing geographical values and so commands our attention.

The Beginning of the Leather Industries 1652–1910

Boots and shoes were among the articles made by the early Dutch settlers in the Cape, but it is unlikely that they formed an important article of exchange or that any real industry developed. With the coming of British rule and the remission of all duty on British goods, the trade in boots and shoes was diverted to British manufacturers[1] and whatever local industry existed was practically killed. The British Government, however, encouraged the export of hides and skins and a considerable trade developed. This was handled mainly through Port Elizabeth which formed the natural outlet for the grazing country to the north. Largely because of the inadequacy of the local supply of tanning materials – due to the scarcity of woodland and the low tanning content of South African tree barks – the tanning industry was slow to develop. In the country ox-hides furnished harness for wagons, and the stock farmers wore leather pantaloons and dried skin shoes. To provide the necessary leather a little rough tanning was done on the farms. Gradually, however, the growing trade in hides and skins encouraged the establishment of small tanneries, particularly in and around Port Elizabeth, where they gave rise to leather and leather working industries. These tanneries

also supplied the farms and small villages of the hinterland, where the manufacture of a crude type of footwear known as 'veldschoen' became quite important during the middle of the nineteenth century. Later as skill was acquired, higher quality shoes were made. The manufacture of boots and shoes also developed in Wellington, Cape Town, and Blanco, near George, its growth at the small isolated centre of Blanco being stimulated by proximity to the Knysna forests, whence tanning bark could be obtained, and by supplies of very soft water favourable for the tanning operations.

The enlarged market and increased trade following the mineral discoveries of the 1870's and 1880's encouraged expansion in the leather industries. By now good-quality sole leather was produced locally but for high-quality footwear it was necessary to import superior uppers leather, mainly from Australia. Tanning agents also had to be imported and these too came mainly from Australia. Expansion, therefore, took place in the ports, particularly Port Elizabeth, which handled most of the trade in hides and skins and formed the nearest port for the Australian trade. Here it was asserted that the boot and shoe industry was favoured by 'a much more varied supply of raw hides and skins than in any country in the world' and that these could 'be bought at much lower prices than in European towns'. Tanning materials were relatively cheap and excellent leather was produced. These opportunities attracted skilled craftsmen from England and during the latter part of the nineteenth century a boot and shoe industry producing high-quality footwear became well established not only in the Eastern Province with Port Elizabeth as the main centre but also in the Western Province where Cape Town and Wellington were the leading centres. Operations, however, remained on a small scale and fewer than 600 people were employed. Moreover, while the infant industry could more than hold its own in the production of high-quality footwear it had difficulty in competing with the cheap imported article. Indeed this problem engaged the attention of two separate parliamentary committees, one in 1883 and another in 1891. Nevertheless in spite of the difficulties, expansion apparently continued for during the last decade of the century imports of leather increased by 50 per cent whereas those of boots and shoes increased by only 30 per cent.

The demand for harness and saddlery during the Anglo-Boer war brought the Cape leather manufacturers a short-lived boom, but the war and rinderpest which swept the country in 1898 caused such a reduction in the cattle population that the supply of hides fell short of requirements and leather had to be imported from the Argentine and Australia. By 1904 imported leather had obtained such a grip on the market and was selling at such low prices that the local tanners began to lose their trade even in the rougher type of leather. At the same time the boot and shoe manufacturers found that even their high-grade footwear could no longer compete with the mass produced article from England and America where machine methods of manufacture had become widespread. By the time of Union, despite the imposition in 1906 of duties of 15 per cent on boots and shoes and of

25 per cent on harness and saddlery the production of high-quality footwear and leather goods had declined and attention was concentrated on veldschoens and other low-quality products.

The Growth of the Leather Industries 1910–1939

Along with other industries boot and shoe manufacture expanded in the period of industrial growth following Union. By 1914 there were 41 factories (36 of them in the Cape and 11 in Port Elizabeth alone) employing about 900 people. Further expansion occurred during the first world war when the restriction of imports gave the industry a measure of protection hitherto unknown, and the demand for army boots created a large market. By 1919–20 the number of boot and shoe factories had risen to 147 and the number of employees, to over 6,000. Meanwhile an increasing output of tanbark from the wattle plantations established in the Natal mist belt after 1884 (see ch. 15) and the production of tannin extract after 1916 aided the tanning industry which not only improved the quality of its output of sole leather, but began to produce some uppers leather as well. At the end of the war new boot and shoe factories equipped with modern machinery were built and the total production rose to over 2 million pairs. But by 1920 the industry was again feeling the competition of imported boots and shoes and the Government was faced with the alternative of allowing a process of readjustment to take place with the liquidation of many of the existing factories, or according the industry, which was now capable of furnishing 75 per cent of the country's needs, some measure of protection. It chose the latter, at first prohibiting the import of those classes of footwear which could be made in the Union and later, in 1923, replacing the embargo by a duty of 30 per cent on all imported boots and shoes, with a 2 per cent rebate to British goods, to be in force for five years, after which it was to be gradually reduced to 17 per cent. At the same time the duty on high-grade uppers leather and manufacturers' sundries was reduced to 3 per cent free; this was subsequently extended to other requisites in 1925. The response was immediate, the output of boots and shoes rising from 1·3 million pairs in 1920–1 to nearly 3 million pairs in 1925–6 (Fig. 164). The output from the Port Elizabeth factories alone increased from just under ½ million pairs to over 1·2 million pairs. Increased attention was given to the production of high-grade footwear and even ladies' fashion shoes requiring great skill in design and execution came to be made. Such was the progress achieved and the value of the employment offered, particularly to 'civilized labour' that in 1928 the Government decided to continue the existing protection at 'this critical stage' in the development of the industry. When soon afterwards the industry was threatened by the import of cheap ladies' fashion shoes made by the Bata Company in Czechoslovakia it was accorded a further measure of protection. Likewise when Japanese competition threatened the manufacture of canvas shoes, which was started in 1930, the local industry was protected by heavy duties on the imported article. With the home market thus reasonably assured the footwear industry steadily increased the scale

of its operations and the variety of its products down to the outbreak of war in 1939. In that year the industry employed nearly 7,000 Europeans and over 3,000 Non-Europeans and achieved a total output of over 13 million pairs of footwear of which 8 million comprised leather boots and shoes, 3½ million canvas shoes and

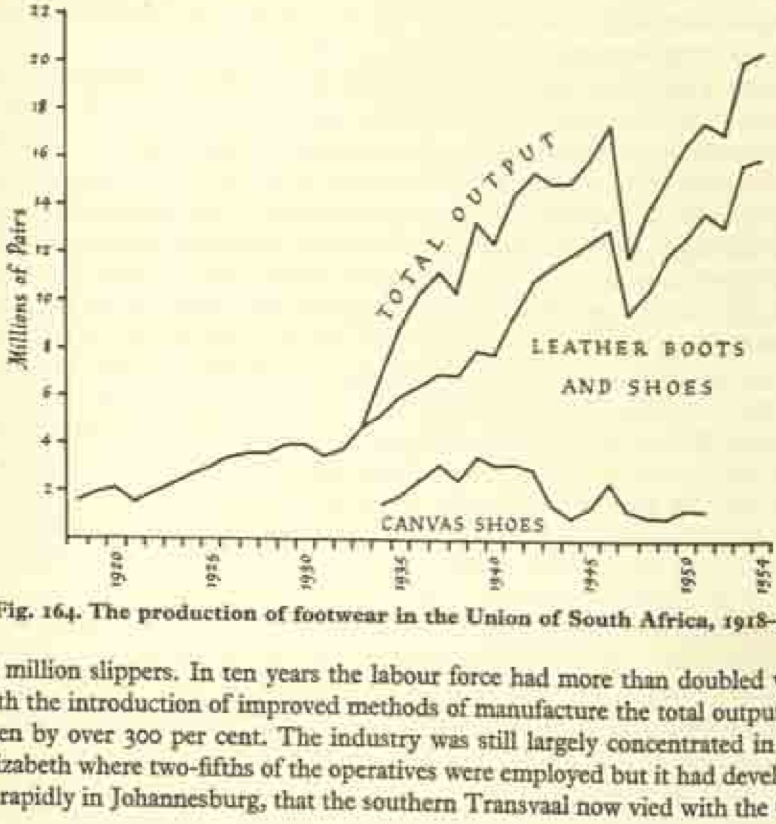


Fig. 164. The production of footwear in the Union of South Africa, 1918–54.

1½ million slippers. In ten years the labour force had more than doubled while with the introduction of improved methods of manufacture the total output had risen by over 300 per cent. The industry was still largely concentrated in Port Elizabeth where two-fifths of the operatives were employed but it had developed so rapidly in Johannesburg, that the southern Transvaal now vied with the Cape

Table 22. Employment in the Boot and Shoe Factories and Tanneries of the Union of South Africa 1918–19 to 1948–9

Year	*Boot and Shoe Factories*				*Tanneries*			
	E	*A*	*C*	*N*	*E*	*A*	*C*	*N*
1918–19	1,668		1,726		299		1,110	
1928–9	3,145	240	1,397	175	343	22	601	666
1937–8*	6,789	623	1,977	683	395	54	418	831
1948–9	6,015	1,874	5,385	1,520	441	136	698	1,848

E = Europeans. *A* = Asiatics. *C* = Coloureds. *N* = Natives.
* Figures for 1938–9 not available.

Western area for second place; the industry had also become firmly established in Pietermaritzburg and Durban.

Meanwhile, however, the tanning industry made little progress. Between 1928–9 and 1938–9 the number of people employed remained static at just under 400 Europeans and about 1,300 Non-Europeans, mainly Africans. And while there was some increase in the output of tanned hides there was a considerable decline in the number of sheepskins and goatskins dealt with.

Both geographical and socio-economic factors were responsible for the retarded development of the tanning industry. In the first place, owing to the conditions under which the cattle were reared, South African hides were seldom free from tick marks, branding marks, damage from barbed wire, and from the effects of hard draught work. They were unsuitable for the production of high-grade uppers leather, for which purpose hides and skins had to be imported. The small market limited the South African tanners to the production of a few popular lines. The import of dressed uppers leathers was therefore essential, and in order to aid the boot and shoe manufacturers they were allowed in duty free. It was not possible to protect both the tanning and the boot and shoe industries, and since the latter provided the market essential for the development of the former it was accorded preference. Moreover, boot and shoe manufacture provided employment mainly for Europeans, including Poor Whites and to a lesser extent for Coloured people, whereas the tanneries employed mainly Africans. From the employment angle, therefore, the protection of the boot and shoe industry was considered the more urgent.

Table 23. Union of South Africa. Output of Leather Boots and Shoes from the Leading Producing Centres 1939–54 (million pairs)

	Midland and Border	*Cape Town and North-west*	*South-west Districts*	*Natal*	*Transvaal and OFS*	*Union*
1939	2·74	1·52	1·14	0·78	1·81	8·02
1945	4·28	1·95	1·26	1·80	3·24	12·56
1954	4·65	2·93	1·35	3·25	3·70	15·90

The Expansion of the Leather Industries 1939–54

The outbreak of war in 1939 inaugurated a period of rapid development in the boot and shoe industry; for not only were the manufacturers once again completely protected from overseas competition, but they were called upon to provide footwear for Allied forces serving in African and Asian theatres of war. By 1945, in spite of difficulties over the supply of machinery, the total output approached 16 million pairs of which 12½ million pairs comprised leather boots and shoes – an increase of more than 50 per cent over the pre-war figure (Table 23). In addition to exports of military footwear which between 1942 and 1945 totalled 8 million

pairs, South Africa had entered the civilian export trade, sending over one million pairs to other African territories in 1945. Apart from a brief recession, which was arrested by the introduction of import control in 1948, the expansion continued in the post-war years. New machinery was installed and by 1954 the annual output exceeded 20 million pairs.

The greatly increased market for all leathers and the war-time restrictions on the import of uppers leathers stimulated a great expansion in the tanning industry, which was maintained in the post-war years. In ten years the consumption of South African leather by boot and shoe factories more than doubled – from 6 million square feet in 1938–9 to 14 million square feet in 1948–9 to 16½ million square feet a year later – while that of imported leather rose only from 11 million square feet to 16 million square feet. In 1949–50 the consumption of South African leather actually exceeded that of imported leather for the first time. Moreover, the South African tanneries not only doubled their output of sole leather – from 10½ million lb. to 19 million lb. but they trebled their production of uppers leathers – from 5½ million lb. to 15 million lb.

The expansion in the tanning industry occurred mainly in Durban and Pietermaritzburg, which were favoured by proximity to wattle extract factories in Durban and the Natal Midlands, and in the southern Transvaal where chrome salts for tanning uppers leather were readily obtained from Kroondal. The industry advanced also in the traditional centres of the Cape Province. In the manufacture of boots and shoes Port Elizabeth remained pre-eminent but the greatest increases in employment and output occurred in the southern Transvaal and Natal.

The expansion of the leather industries was marked by three important features: larger factories – by 1948–9 there were 32 employing some 200 workpeople and 9 employing over 500 – increasing mechanization and, associated with it, the increasing employment of Non-European labour (Fig. 165). Between 1938–9 and 1948–9 there was actually a drop in the number of Europeans employed but a sharp rise in the employment of Coloured people in the boot and shoe factories in Port Elizabeth, Cape Town, and Johannesburg, of Asiatics in Natal, and of Natives in the tanneries and boot factories on the Witwatersrand.

Today the boot and shoe industry is firmly established and provides employment for over 17,500 workers. It is concentrated in Port Elizabeth, Johannesburg, where the manufacture of mining boots is a speciality, Cape Town, Durban, and Pietermaritzburg, while outlier factories occur at Wellington, George, and Great Brak River, a legacy of the early development of the industry there. A wide range of articles are produced, including ladies' fashion shoes, but where South African uppers are used the coarse grain of the leather caused by the rapid growth of the animals under South African conditions prevents a high finish. The value of the output exceeds £14 million gross and £6½ million net. This is about equal to the output of the recently established textile factories and far below that of the leading industries of the country. The industry, however, is able to supply the entire

Table 24. Union of South Africa. Employment in the Leather Industries in the Main Industrial Centres 1918–19 to 1948–9

Year	Port Elizabeth and Uitenhage					Cape Western					Southern Transvaal				
	E	*A*	*C*	*N*	*T*	*E*	*A*	*C*	*N*	*T*	*E*	*A*	*C*	*N*	*T*
1918–19	841		612		1,453	272		913		1,185	242		202		444
1928–9	1,697	21	601	374	2,693	508	13	827	146	1,494	720		182	253	1,155
1937–8	2,927	19	227	445	3,618	1,208	2	3,026	115	4,351	1,280	2	36	652	1,970
1944–5	3,305	94	1,767	946	6,112	1,199	12	2,163	403	3,777	1,537	51	1,346	1,442	4,376
1948–9	2,398	143	2,028	878	5,447	1,243	34	2,521	270	4,078	1,179	35	1,436	1,309	3,959

Year	Natal					Union				
	E	*A*	*C*	*N*	*T*	*E*	*A*	*C*	*N*	*T*
1918–19	133		562		695	2,525		3,548		6,073
1928–9	199	258	126	256	839	4,177	294	2,492	1,101	8,064
1937–8	608	681	114	415						
1944–5	524	1,701	426	1,218	3,969	9,191	1,863	6,494	4,716	22,264
1948–9	488	1,397	413	1,310	3,608	7,311	2,152	7,299	4,181	21,943

E = Europeans. *A* = Asiatics. *C* = Coloureds. *N* = Natives.

Table 25. Union of South Africa. Employment in the Boot and Shoe Factories in the Leading Centres 1945 and 1954

	Midland and Border		*Cape Town and South-west*		*South-west Districts*		*Natal*		*Transvaal and OFS*		*Union*	
	E	*NE*	*E*	*NE*	*E*	*NE*	*E*	*NE*	*E*	*NE*	*E*	*NE*
1945	3,130	2,130	997	1,469	1,677	158	338	2,321	1,190	1,795	7,332	7,873
1954	2,039	3,114	898	2,291	1,518	289	410	3,794	766	2,585	5,581	12,073

E = Europeans. *NE* = Non-Europeans.

home market – imports have dropped to negligible amounts – and furnish a small export. As yet the Non-European market is relatively little developed, total purchases by these people falling short of those made by Europeans. The future expansion of the boot and shoe industry will depend largely on its ability to cater for this market and to compete in similar markets in other African territories.

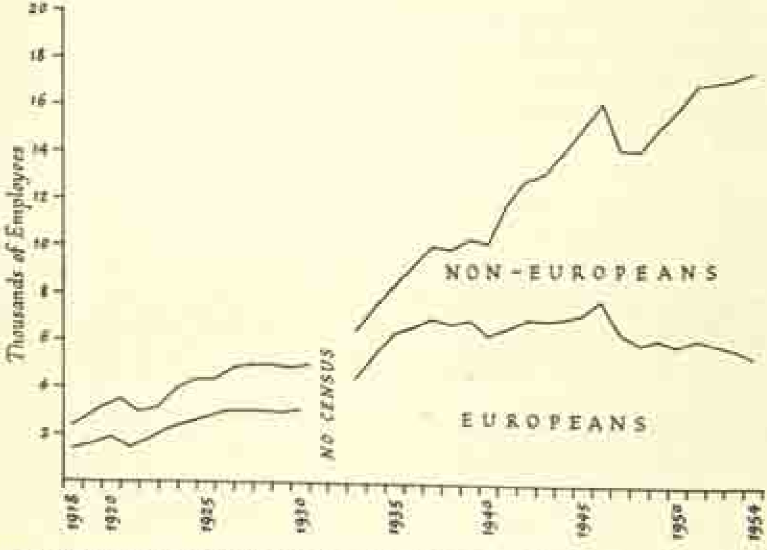


Fig. 165. The labour force of the footwear industry of the Union of South Africa, 1918–54.

The tanning industry is less securely established and has suffered some recession in the post-war years. It is concentrated mainly in Port Elizabeth, the southern Transvaal, and Durban–Pietermaritzburg, but small tanneries are widely distributed in rural centres throughout the country. Altogether they employ about 3,000 people. South Africa affords many opportunities for the develop-

ment of a tanning industry, but economic considerations have prevented their full exploitation. Apart from being a large producer of hides and skins, she leads the world in the production of tanning grade chrome, and wattle bark and extract. Hitherto these resources have been largely exported. The limiting factor has been and remains the small home market and here the future of the tanning industry depends on the future of the leather consuming industries.

Leather industries other than boot and shoe manufacture are relatively unimportant. The manufacture of harness and saddlery has declined with the growth of mechanized transport, and while the making of handbags, all kinds of travel goods and gloves has become important particularly in Johannesburg, changes of fashion are bringing about the use of a variety of new materials instead of leather in their manufacture.

BIBLIOGRAPHY

1. H. SCHAUDER. 'An economic history of the boot and shoe industry in South Africa'. *S.A. J. Econ.*, Vol. III, 1935, pp. 502–47.

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The Chemical Industries

Both with regard to employment and value of output the chemical industries rank fourth in importance, being surpassed by the metal and engineering, the food and drink and the textile and clothing industries. In 1950–1 they employed more than 31,500 workers and their output was valued at nearly £73 million gross and over £30 million net. But their importance cannot be measured simply in terms of employment and value of output for there is no group of industries which has a wider significance on the general development of the country; moreover every year brings new substances and new uses for old substances as the efforts of chemist and engineer are combined to meet the ever-changing needs of a rapidly changing world. Agriculture depends increasingly on artificial fertilizers, the mines require explosives and cyanide, and in the manufacturing industries synthetic products, possessing certain superior and much needed qualities, are replacing substances of natural origin.

There are many opportunities for the development of a great variety of chemical industries in South Africa. Many of the basic raw materials are produced in the country and cheap electricity is available in the main centres. Coal, a most vital chemical raw material as well as a source of energy, is cheaper than anywhere else in the world. Large quantities of salt, a primary raw material in the manufacture of soda and alkalis, are produced. Extensive deposits of limestone and phosphate suitable for the preparation of fertilizers and the former also for use in the production of alkalis and carbide, exist. Pyrites for the manufacture of sulphuric acid, often referred to as 'the barometer of industry' on account of the immense number of processes which depend upon its use at some stage, is obtainable as a by-product of the gold mines. Molasses, one of the most important raw materials for the manufacture of alcohol solvents, are a by-product of the Natal sugar cane industry. Large quantities of both marine and vegetable oils used in the manufacture of edible oils, soap and paint are produced in the country, the former provided by both the whaling and fishing industries, the latter derived from home-grown groundnuts and sunflower seeds. In addition a variety of secondary raw materials are available – chrome ore and wattle bark for the preparation of tanning agents, titanium oxide and ochres for pigments.

Hitherto, development in the chemical industry has been in a comparatively narrow field, mainly because the internal market is relatively limited and the capital cost of establishing chemical plants is comparatively high. Wherever the internal demand has justified the capital expenditure, however, the requisite plants have been established. The explosives industry, built up to supply the vast market on the gold mines, was the first in the field and today boasts the two largest explosives plants in the world. Fertilizer and soap factories followed. During the 1939–45 war the manufacture of insecticides began and since then large plants for the production of oil-from-coal and the manufacture of margarine have been established. With the basic chemical industries thus established the way is now open for the development of a range of lighter chemical industries using the by-products of the heavy chemical industries as their raw materials.

The Heavy Chemical Industry

The heavy chemical industry embraces the manufacture of those chemicals, both inorganic and organic, which are required in large quantities and have a variety of uses. In South Africa it includes the explosives industry, the production of motor spirit from torbanite and coal and of alcohol from molasses and maize.

The heavy chemical industry dates from 1892 when two black powder factories were established near the present Premier Diamond mine by a company called De Zuid-Afrikaansche Fabrieken voor Ontplofbare Stoffen, Beperk. Having obtained a monopoly in the manufacture and sale of explosives from the Kruger government and with capital from the French and German explosives trusts founded by Nobel, the same company began two years later to erect a nitroglycerine explosives works at Modderfontein, twelve miles north-east of Johannesburg.[1] Several considerations dictated the choice of site. Reasonable proximity to the Rand gold mines was important and for safety reasons a site in open country well removed from the built-up area was necessary. Access to the East Rand coalfield suggested a site east of Johannesburg and the supplies of water carried by the Jukskei river together with the opportunities for the construction of dams along its course led to the choice of Modderfontein (Plate 70). The choice proved to be a happy one and on this site covering 8 square miles the largest explosives factory of the world has since grown up. At first, however, difficulties were experienced. All the raw materials had to be imported – saltpetre for the production of nitric acid from Chile, sulphur for sulphuric acid from Sicily and refined glycerine from the United Kingdom. The Modderfontein works was handicapped by its inland situation while the possession of a monopoly tended to inflate the price of explosives. In an attempt to provide cheaper explosives for the Kimberley diamond mines the de Beers interests decided to erect their own factory. Proximity to Cape Town for the import of raw materials and coal was an important consideration in the choice of location. The availability of ample supplies of fresh water, together with opportunities for the safe disposal of effluent led to the selection of a site near the point where the Lourens river enters the sea at

Somerset West. Here too a belt of sand dunes provided natural safety mounds. The works – known as the Cape Explosives Works Ltd – were completed in 1903. Meanwhile the war ended, the British South African Explosive Co. Ltd, in which Nobel interests held a large part of the shares, came into being in 1902 and took over the Modderfontein factory. Such was the expanding market for explosives on the mines that in 1908 Kynoch Ltd, the Birmingham firm of explosives manufacturers, erected a factory on a 1,400 acre site at Umbogintwini, sixteen miles south of Durban. At this stage the need for importing raw materials favoured coastal locations while proximity to the Natal coalfields gave a site near Durban an obvious advantage over one near Cape Town. The first world war gave a tremendous impetus to the explosives industry, which, however, with its dependence on overseas raw materials, was ill-prepared to meet the demands made upon it. As in other countries it was only under wartime conditions that the full significance of the German Haber-Bosch process, whereby the nitrogen of the air and hydrogen derived from water were converted into ammonia, which could then be converted into nitric acid and of the Norwegian process by which the nitrogen of the air could be fixed in a strong electric current, came to be appreciated. Progress, however, was slow for the erection of plants for ammonia synthesis and nitrate fixation involved considerable capital outlay and presented many technical difficulties. These considerations led first to the amalgamation of the Modderfontein and Umbogintwini interests as Nobel Industries and eventually in 1924 to that of all three factories on the formation of African Explosives and Chemical Industries, now a subsidiary of Imperial Chemical Industries Ltd. Thereafter explosives manufacture became concentrated at Modderfontein and the Umbogintwini factory was developed as a chemical factory principally for the production of fertilizers and other farm requisites such as cattle and sheep dips and insecticides. Both explosives and fertilizers came to be made at Somerset West. By now it was clear that Modderfontein, with large supplies of coal and electricity at hand, provided the best site for an ammonia synthesis plant. This came into operation in 1931, since when Modderfontein has supplied both its own ammonia needs and those of the Somerset West factory. Meanwhile pyrites, a by-product of the gold mines, partially replaced sulphur in the production of sulphuric acid and increasingly supplies of glycerine were obtained as a by-product of the soap industry (see pp. 466–8). Thus the explosive industry founded on the basis of imported products came to rely on Union raw materials and at the same time extended its activities to include the production of heavy chemicals surplus to its needs. With these developments the advantage of location shifted to the southern Transvaal.

Meanwhile attempts to produce nitrogenous compounds had been made in other directions. One promising method was the manufacture of cyanamide from calcium carbide. Cyanamide, known in the impure condition as 'nitrolim' is itself a good fertilizer and when correctly treated with superheated steam gives off ammonia which can be readily oxidized to nitric acid. Since South Africa, besides

being a large consumer of fertilizer and nitric acid, also required calcium carbide for use in miners' lamps on the gold mines, this process commended itself. Shortly after the first world war two factories were established, one at Witbank and the other at Ballengeich in Natal. Calcium carbide is obtained by the fusion of lime and coke at very high temperatures. Its manufacture requires large quantities of coal and limestone and enormous quantities of electricity. Hence the location of the factories on the coalfields where both coal and cheap electricity were available.

The foundations of an organic heavy chemicals industry were also laid during the inter-war period. The production of anhydrous alcohol from molasses was a natural development from the Natal sugar refining industry. By 1933 the output reached $1\frac{1}{2}$ million gallons of which $\frac{1}{4}$ million gallons were used for motor fuel. The most important development, however, came with the decision to utilize the torbanites of the Ermelo coalfield in the production of petrol. In 1932 the South African Torbanite Mining and Refining Co. (SATMAR) was formed 'to refine and market indigenous petrol obtained by blending petrol from oil shale, alcohol from maize and molasses, and benzol from Iscor'.[2] The retorting plant was naturally erected on the coalfield, actually at Torbanite, 11 miles north of Ermelo while ease of assembly of the various raw materials – crude oil and maize from the eastern Transvaal, molasses from Natal and benzol from Iscor – led to the selection of Boksburg as the site for the refinery. Pending the completion of the retorting plant, the refinery which came into operation in 1934 used imported crude oil. The first retort was completed in 1937 when, however, a reduction in the price of imported petroleum and motor spirit threatened the entire enterprise. Indeed it was saved only by a concession permitting the continued refining of imported crude oil, the profits from which offset the expenses incurred in refining torbanite. The arrangement was conditional on a fixed minimum output of petrol from torbanite crude in any one year. In 1938 over 36,000 tons of torbanite were retorted and yielded on refining over 1 million gallons of petrol. In 1939 the output rose to 1·4 million gallons. At the outbreak of war the home oil from shale industry had at least been established.

The second world war brought about an expansion in the existing chemical industries, notably explosives (Figs. 166 and 167) and led to the development of new ones. Most important was the establishment in 1941 of a chemical warfare factory, with a central chlorine generating plant, at Klipfontein adjacent to Modderfontein. The main raw materials needed were salt, benzol, alcohol, sulphuric acid and coal. Apart from salt all were available locally and largely determined the location of the works. The actual site was governed by the facilities for obtaining water and disposing of effluent and by remoteness from built-up areas. The chlorine generating plant later enabled the factory to take up the manufacture of D.D.T. and after the war its activities were extended to the production of benzene hexachloride, also by a chlorination process. In 1946 the factory was transferred from the Department of Defence to that of Commerce

and Industries by whom it was operated until 1950 when it was taken over by Klipfontein Organic Products Corporation. It now employs about one thousand people and has extended its operations to include the manufacture of a wide range of chlorinated insecticides which are used all over Africa, particularly for the control of locusts and tse-tse fly, and are exported to many countries of the world.

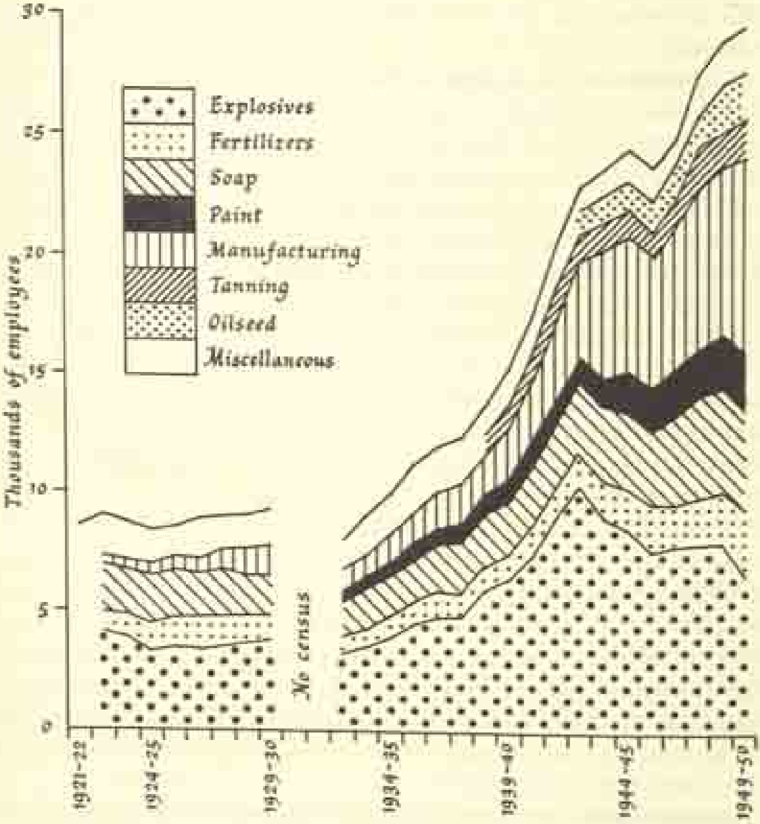


Fig. 166. The number of employees engaged in the various branches of the chemical industry of the Union of South Africa, 1921–50.

The by-products of the factory – caustic soda, hydrogen and hydrochloric acid – form the raw materials for other industries and already a number of chemical firms have become established in a nearby industrial township. Indeed the Modderfontein–Klipfontein area promises to become the great centre of chemical industry in Southern Africa.

The need for more explosives to supply the new goldfields and a desire for greater self-sufficiency in the production of fertilizers and petrol, arising from acute wartime shortages of these commodities, led to two major developments in

the heavy chemical industry in the post-war years – namely the erection of a new £4 million plant to produce ammonia from atmospheric nitrogen at Modderfontein and the development of a great oil-from-coal project on the Vereeniging coalfield near Coalbrook.

In 1953 the Union's annual output of ammonia was around 50,000 tons coming mainly from the nitrogen synthesis plant at Modderfontein and the by-product coke ovens on the Natal coalfield and at the Iscor works. When the new plant comes into operation the output will exceed 80,000 tons, sufficient to meet all the needs of the explosives and fertilizer industries (see p. 469). The

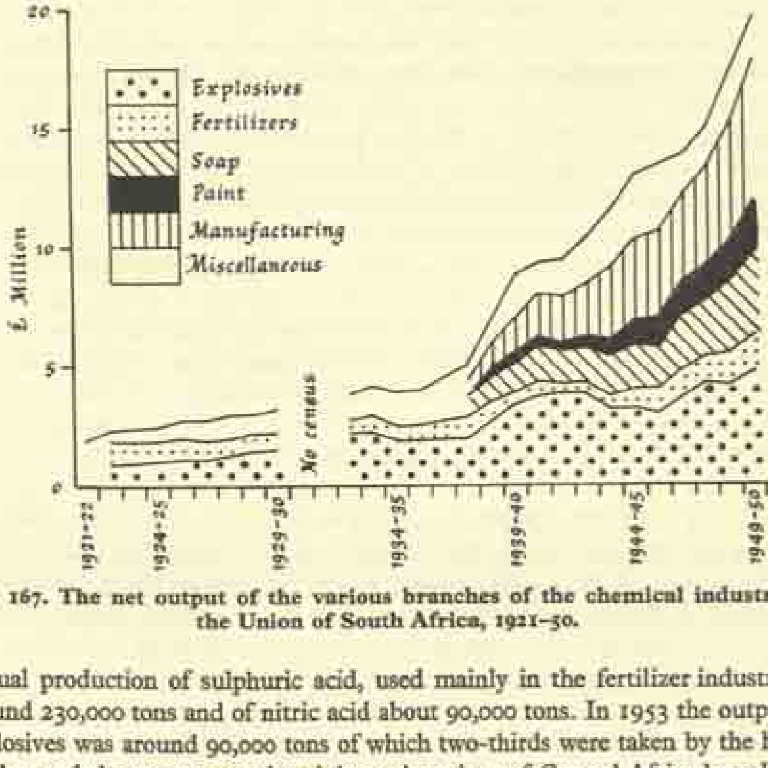


Fig. 167. The net output of the various branches of the chemical industry of the Union of South Africa, 1921–50.

annual production of sulphuric acid, used mainly in the fertilizer industry, is around 230,000 tons and of nitric acid about 90,000 tons. In 1953 the output of explosives was around 90,000 tons of which two-thirds were taken by the home market and the rest exported mainly to the mines of Central Africa but also to Asian countries. At present about 40,000 tons of carbide are produced annually. This output is small in comparison with that of the U.S.A. – 700,000 tons per annum – but nevertheless one-half is exported. The individual factories are comparable with those of the U.S.A. both as regards size and efficiency and with favourable power and raw material resources the industry is capable of expansion.[3]

During the war and post-war years the production of crude oil from torbanite was increased so that by 1950 it approached 10 million gallons per annum.

This, however, provided only a very small part of the country's liquid fuel requirements of 600 million gallons per annum. Meanwhile, the Union, without petroleum reserves but with an abundance of cheaply exploitable coal, had been intensely interested in the attempts made in other countries to produce liquid fuel from coal and had actually acquired manufacturing licences for the Fisher-Tropsch process soon after the initial application in Germany over 25 years ago. Plans for the establishment of a plant in South Africa were interrupted by the second world war but in 1950 the South African Coal, Oil, and Gas Corporation Ltd (SASOL) was formed and work began on a £30 million project financed very largely by the Government but also by American capital. Apart from the obvious requirements of coal and water, the actual choice of site – by the Vaal river on the Vereeniging coalfield – was governed very largely by access to the market both for fuel oil and for by-products. From physical standpoints equally good sites exist on the eastern Transvaal coalfields, where indeed further plants may be established later. The Sasol plant (Plate 66) which came into operation in 1954, is the largest plant for the synthesis of oil from coal in the world.[4] It consumes 7,000 tons of coal, obtained from its own colliery on the site, and 7,500 tons of air per day for the gasification to hydrogen and carbon monoxide which form the corner stones of the synthesis reaction which results in the complicated chemical compounds making up liquid fuel.[5] The plant is capable of producing 50 to 60 million gallons of gasoline and 5 to 6 million gallons of diesel oil per annum. Among its by-products are 9,000 tons of ammonia liquor, 10,000 tons of tar acids, 6 million gallons of ethyl and higher alcohols, 1 million tons of mixed solvents and 14,000 tons of paraffin wax. Tar acids are used in the production of plastics and synthetic fibres, and ethyl alcohol and benzene in the manufacture of synthetic rubber.

In 1954 also the first petroleum refinery in South Africa came into operation. Built by the Standard Vacuum Oil Co. it is located at Durban, the nearest South African port to the Middle East oilfields and to the great market of the southern Transvaal, to which a pipeline has been laid for the conveyance of refined motor spirit. The refinery deals with 200 million gallons of crude oil per year. More than 120 million gallons of petrol and nearly 200 million gallons of diesel oil are produced each year so that more than half the Union's liquid fuel requirements are now refined in the country.

Thus by 1954 a number of basic heavy chemical industries had been established in the Union, offering in their by-products the raw materials for a variety of lighter chemical industries.

The Soap and Edible Oils Industry

The soap-making industry began towards the end of the nineteenth century when yellow soap was made from local tallow and imported vegetable oil at factories in the eastern Cape and southern Transvaal.[6] The growth of the modern industry, however, dates from the establishment of factories by Lever Bros Ltd

in Cape Town in 1904 and Durban in 1911.[7] Since the main raw materials – vegetable oils and caustic soda – had to be imported, the ports offered obvious advantages for the siting of the industry while the selection of Durban for the main factory (Plate 71) was influenced by the availability of whale oil which was processed and hardened locally, by its trade connexions with South East Asia whence came coconut-oil and by its lesser distance from the Witwatersrand markets. The advantages of proximity to this large market, combined with railage rebates on raw materials, however, led to the establishment of a number of factories on the Rand and eventually Lever Bros erected one at Auckland Park on the northern outskirts of Johannesburg. In 1937 the spread of the industry was extended when Colgate-Palmolive Ltd, chose East London with its proximity to the labour pools of the Transkei and Ciskei, as the centre for a large modern factory. As in so many other industries in South Africa soap manufacture is thus distributed between the main population centres.

At first production centred on household and laundry soaps, the output of which increased steadily after the Great Depression. Since 1939, however, the production of toilet and special scouring soaps and of flakes and powders has become important (Fig. 168). After 1944 the competition of detergents brought a decline in the output of laundry soaps, but production now seems to have stabilized.

Soap manufacture still depends very largely on imported raw materials. Local industries provide some tallow and caustic soda, but insufficient quantities are available, and the major requirements have to be imported – tallow from Australia and the U.S.A., caustic soda from England. Today whale oil provides only about 13 per cent[8] of the total fat and oil used owing to its high price consequent on technical improvements in its processing which have made it suitable for the production of edible oils. Palm oil and palm kernel oil are obtained from Nigeria and the Belgian Congo, coconut oil from Ceylon, the Philippines and Indonesia, small quantities of olive oil from the Mediterranean basin. Altogether 70 per cent of the raw materials used in the industry are imported, but the exceptionally favourable position of the country midway between the African and Asian suppliers of vegetable oils promises the continued expansion of the industry.

Since the processing of oils plays an important part in soap manufacture it was natural that attention should be directed to oil-expressing and the manufacture of edible oil products. This was undertaken by Lever Bros and by a number of manufacturers on the Rand. Before the second world war the home oil-expressers depended very largely on imported oilseeds and their output was inadequate for home needs. After 1939 the industry developed rapidly, receiving a considerable fillip from the great extension in the growing of groundnuts on the Springbok Flats and of sunflower seeds on the Transvaal Highveld (ch. 11, p. 197). By 1951 their output had nearly trebled (Table 26).[9] At the same time the manufacture of edible oils expanded. At first cooking fats and salad oils were the

leading products but with the rapid growth of the urban African population during and after the war a large market for margarine developed, particularly after 1945 when the Government decided to distribute margarine instead of subsidized 'State Aided' butter to the people in the lower income groups in the urban areas. By 1951 the edible oils and margarine manufacturers had become the biggest consumers of vegetable and marine oils in the country (Table 27). The

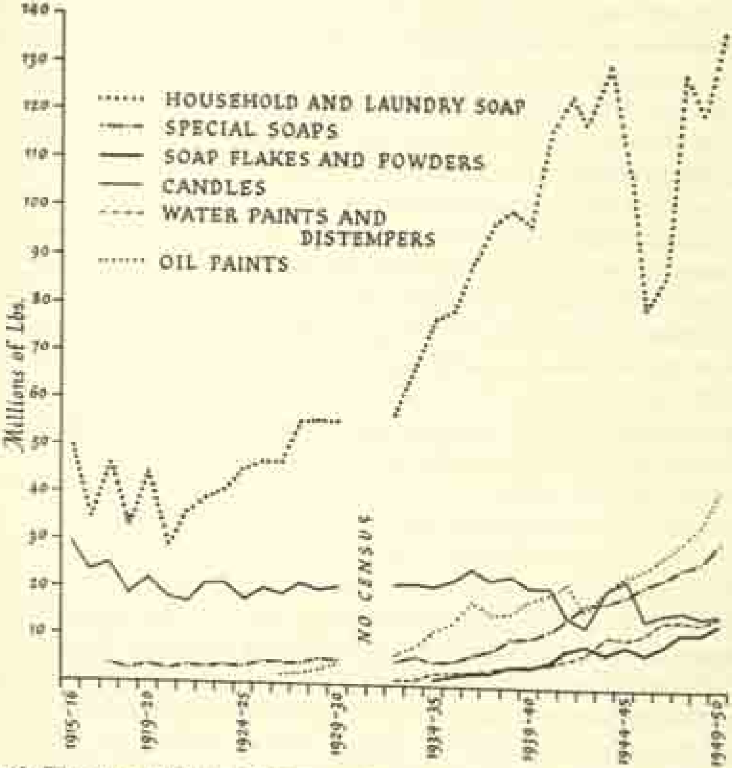


Fig. 168. The production of soaps, paints, etc., in the Union of South Africa, 1915–50.

opportunities for the further expansion of the industry and the enormous potential market among the Bantu peoples prompted Lever Bros to erect a modern edible oils and fats factory at Boksburg in 1954–5 (Plate 72). This factory occupies the largest Lever site in the southern hemisphere, the site being chosen for its proximity to the Witwatersrand market and central position for the delivery of groundnuts and sunflower seeds and despatch of processed articles. Thus in taking advantage of geographical circumstances the activities of Lever Bros have become more widespread, in marked contrast to their concentration on Merseyside in England.

*Table 26. Union of South Africa. Consumption and Output of Vegetable and Marine Oils 1938 and 1951. (Short tons)**

	1938		*1951*	
	Union Consumption	*Union Output*	*Union Consumption*	*Union Output*
Vegetable Oils				
Annual Plants	21,237	14,382	33,744	39,256
Trees	24,392		13,959	1,114
Total	45,629	14,382	47,703	40,370
Marine Oils				
Whale Oil	3,790	29,073	5,229	47,080
Fish Body Oil	136		15,099	16,465
Total	3,926	29,073	20,328	63,545
Grand Total	49,555	43,455	68,031	103,915

* From 'The marine oils industry of the Union'. *Comm. and Ind.* December 1953.

*Table 27. Union of South Africa. Consumption of Vegetable and Marine Oils by Different Industries 1951. (Short tons)**

	Vegetable Oil	*Fish Body Oil*	*Whale Oil*	*Total*
Edible Oils and Fats and Margarine	26,090	5,900	3,160	35,150
Soap	12,270	3,770	1,940	17,980
Paint	6,860	2,987		9,847
Other Industries	2,483	2,442	129	5,054
Total	47,703	15,099	5,229	68,031

* From 'The marine oils industry of the Union'. *Comm. and Ind.* December 1953.

Other Chemical Industries

Of the remaining chemical industries the manufacture of fertilizers and of paint are most important. Before the second world war South Africa was virtually dependent on imports of fertilizers despite their manufacture at the Umbogintwini and Somerset West explosives factories since the beginning of the century. Consumption was well below the requirements of healthy agriculture. The acute shortage of fertilizers during the war and an increasing consciousness of the need for maintaining soil fertility as a safeguard against soil erosion then led to a national effort to increase fertilizer production. Since 1939 the total production of all fertilizers had been increased from less than 300,000 tons to about 1 million

tons. In particular the output of phosphate fertilizers has increased with the exploitation of the deposits of phosphate rock at Palabora. The basic fertilizers are produced mainly at Umbogintwini and Somerset West but factories preparing mixed fertilizers are distributed in all the larger population centres.

The manufacture of paint began in East London and Durban in the early part of this century, but although the industry expanded under tariff protection during the inter-war years, its output in 1939 was valued at only £682,000. After 1939 the industry expanded rapidly to meet wartime needs and continued to grow during post-war years. By 1952 the value of the total output exceeded £7 million and in addition to supplying home needs there was a small export. The industry, which is favoured by the home production of oils and pigments is concentrated in Durban which acted as the distributing centre for imported paints and varnishes before manufacturing was undertaken.

The preparation of pharmaceuticals, cosmetics, and other light chemical products is carried on in the southern Transvaal and in the ports, proximity to market being the localizing factor.

BIBLIOGRAPHY

1. *J. of S.A. Inst. Mech. Eng.*, Vol. II, No. 9, 1952.
2. A. R. STELLING and C. G. ROBERTSON. 'Oil shales in the Union'. *S.A. Min. Eng. J.*, Vol. LX, 1950.
3. N. J. MAAS. 'Synthetic organic products. Production possibilities in the Union with special reference to acetylene as a possible raw material'. *Comm. and Ind.*, Vol. 10, No. 12, 1952.
4. F. J. du TOIT. 'Oil from coal in South Africa. A brief review of the history and progress of SASOL and its likely impact on the South African economy'. *Comm. and Ind.*, Vol. XII, No. 7, 1954, pp. 357–9.
5. F. J. de VILLIERS. 'The South African chemical industry', in South Africa, United Kingdom, and Commonwealth Survey. 1954.
6. H. SCHAUDER. 'Chemical industries in South Africa before Union'. *S.A. J. Econ.*, Vol. XIV, No. 4, 1948, pp. 277–87.
7. Lever Bros in South Africa. Brochure.
8. Information supplied privately by the firms concerned.
9. See 'The marine oils industry in the Union'. *Comm. and Ind.*, Vol. 12, No. 4, 1953.

31

Other Industries

Cement Manufacture

Cement occupies a special place in the economy of South Africa for apart from its many uses common to all civilized countries it has played a vital role in mining (i.e. in the Francois cementation of the shafts) and in the construction of storage dams for water supply and irrigation.

The location of the cement industry has been determined by the occurrence within the same area of suitable limestone and clay and by proximity to railways serving the main centres of consumption. At present there are nine factories in the Union with a total output in 1952–3 of over 2 million tons of Portland cement valued at £3 million. They are located in three main areas. Most important is the Lichtenberg–Ottoshoop–Mafeking area in the western Transvaal and northern Cape where, in proximity to the Cape to Rhodesia and Kimberley to Johannesburg railways, the Dolomite provides suitable raw material. Of increasing importance with the development of the Orange Free State goldfield are the factories near Hennenman, which situated near the Cape Town–Bloemfontein–Johannesburg main line, work limestone formed by the decomposition of dolerite of post-Karoo age. Near Cape Town limestone and clay from the Malmesbury Series support an industry providing for the needs of the south-western Cape. At all these works ordinary Portland cement for general purposes, rapid hardening Portland cement and waterproof Portland cement are made, but not special cements which still have to be imported. The total production of the three types of Portland cement more than satisfies Union needs and there is a small export to other African territories.

The Ceramic Industries

The ceramic industries using clay, refractory materials and minerals such as felspar are well established in South Africa.

Common brick clays are widespread and the location of the brick-making industry is governed mainly by proximity to markets. The brickworks are hence concentrated near the big urban centres. In most areas the shales of the Karoo

System provide the most important source of raw materials but in the Pretoria-Witwatersrand-Vereeniging area residual clays derived from shales in the Pretoria Series and weathered shales in the Witwatersrand System are mainly used. Bricks, tiles, and pipes are produced. Production has increased with the general economic development of the country and in recent years the annual output of stock bricks has exceeded 1,000 million, that of facing bricks 200 million, and roofing tiles 25 million.

The manufacture of firebricks, crucibles, and other refractory products is dictated by the restricted occurrence of suitable raw materials. Fortunately, however, these are found near the main markets for refractories. Excellent fireclays are associated with the coal measure rocks, the best and largest deposits occurring in the Witwatersrand region where they are worked in the Springs-Boksburg-Brakpan area, at Olifantsfontein (between Pretoria and Johannesburg) and Vereeniging. Further deposits are known to occur in the Witbank and Wakkerstroom areas.

Most of the coal measure clays are suitable for pottery manufacture. At present they are being used only at Olifantsfontein where excellent articles are being produced. Kaolins associated with granite and pegmatites are worked in Namaqualand and at White River in the Transvaal Lowveld, but as they are not of first quality, they are used mainly as filler for the paint, rubber, and paper industries, and so far no chinaware is produced in South Africa.

Industries using siliceous refractories are less well developed. Silica bricks for use particularly in the iron and steel plants are made from silcrete in the Mossel Bay and Riversdale districts of the Cape. Glass manufacture is carried on at Pretoria and Springs, using good-quality white sands found north-west of the former town and also at Talana near Dundee where a similar deposit is found. As yet production is limited to bottles.

Other Industries

A great variety of other industries are carried on on a small scale in South Africa. Some have a value out of all proportion to their size. Here *diamond cutting and polishing* and the manufacture of *gold plate* deserve special mention. Both are centred in Johannesburg as the commercial centre of the country which attracts overseas buyers. Both have developed rapidly since the war. *Rubber goods*, particularly tyres, are made in Durban (Dunlop Ltd), Uitenhage (Goodyear Rubber Co.), and Howick (South African Rubber Co.) all of which are well placed for the import of raw rubber from South East Asia and are at the same time near the main motor vehicle assembly plants. The manufacture of *cigarette, pipe tobacco and snuff* is concentrated on the Witwatersrand and in Paarl and Cape Town, i.e. near the tobacco-producing areas and in the main consuming centres. The making of high-quality *furniture* from indigenous timber, particularly stinkwood and blackwood, is carried on in Knysna and George near the sources of raw material while the manufacture of other types of wooden and metal furniture as well as of

bedding and soft furnishings is concentrated very largely on the Witwatersrand and to a lesser extent in the other big towns. *Toy* manufacture which experienced a phenomenal growth during the second world war is important in Johannesburg. All the time new industries are being developed and the diversity of manufacture increased but as yet no other industries warrant special mention.

Communications and Trade

32

Land and Air Communications

The pattern of communications in South Africa reflects very closely that of economic development. Basic is the railway system built to connect the ports with the mining centres and subsequently extended to serve the most productive agricultural and industrial areas. The trunk road system is essentially similar but being of later date, the main roads generally pass through more productive country than the railways; secondary roads ramify to most settled parts of the country and in many cases afford links to the railhead. As a result of legislation designed to protect the railways from the competition of road haulage services, the latter services are ancillary to those of the railways as far as freight traffic is concerned. Air transport is of recent date; following the general pattern of population distribution and economic activity the system is centred on Johannesburg and provides links with all the main towns and with overseas countries.

The Evolution of the Railway Network

The development of the trunk railways of South Africa was occasioned very largely by the major mineral discoveries while the routes followed were determined by the physical features of the country traversed and, prior to Union, by the economic policies of the individual colonies and republics through which they passed. Since 1910 the elaboration of the network has gone hand in hand with the general economic development of the country.

The growth of the railway network is shown on Fig. 169. The first railways were built during the middle of the nineteenth century by private joint stock companies in order to link the ports of Cape Town and Durban with their immediate hinterlands. The Paarl–Wellington area then supported a closely-settled farming community producing surplus wine and grain for the Cape Town and overseas markets. Transport by ox-wagon to Cape Town was slow while the shifting sands of the Cape Flats, then in process of being fixed, interposed a 20-mile belt in which there was no grazing for the animals. A railway was needed and economically the hinterland could support one. Work began in Cape Town in 1859; by 1862 the line was opened to Stellenbosch and a year later to Wellington,

a total distance of 59 miles. A 3-mile line from Cape Town to the wine-producing area of Wynberg was opened in 1864. In Natal a railway, 2 miles long, linking the Point to Durban, was completed in 1860 and the line carried a further 3 miles to the Umgeni river in 1874. All these lines traversed level country and were built on the English standard gauge of 4 feet 8½ inches. During their construction the Eastern Province demanded similar facilities. Port Elizabeth and East London were, however, competing for the trade of this area. For political reasons it was not possible to build a railway inland from one and not the other, but economically the hinterland could not support two railways. Port Elizabeth formed the natural outlet for the grassland country of the eastern Karoo as well as for the good agricultural land near the coast. East London's immediate hinterland was agriculturally undeveloped but the port formed the gateway to the sheep farming country extending northwards to the grasslands of the eastern Free State. Inland from each port stiff gradients were soon encountered, the distances to the productive country were great and the only important commodity offering, namely, wool was satisfactorily carried to the ports by ox-wagon. In face of all these factors and of isolation from Cape Town, the financial centre of the Cape Colony, no lines were built.

With the opening of the Kimberley diamond fields the picture changed. Port Elizabeth and East London, both nearer than Cape Town to Kimberley, became busy ports of entry for goods and equipment destined for the mines. For people and mails, however, the shortest route between Kimberley and Europe was via Cape Town. All three ports demanded rail connexions to Kimberley. And in order to meet the several needs and give each port a 'fair share' of the traffic, three separate lines were pushed inland although one line either from Port Elizabeth or East London would have been adequate for the heavy freight traffic. In 1873 the Cape Town–Wellington line was purchased by the Cape Colony, its extension to Worcester and the construction of a line from Port Elizabeth to East London authorized. Next year consent was given for a line from East London to Kingwilliamstown and the extension of the Cape Town and Port Elizabeth lines. In 1875 the Natal Government obtained authority for the purchase of the Point–Durban–Umgeni railway, for its extension inland towards Pietermaritzburg and for the construction of branch lines to Verulam and Isipingo in the sugar belt. The main lines had to negotiate steep gradients over the Cape mountains and the Great Escarpment and they had to traverse vast stretches of underdeveloped country, much of it of low potential productivity. Physical and economic considerations led to the adoption of a narrow gauge – 3 feet 6 inches – on all main lines, thereby limiting the carrying capacity of the railway system for the future.

While Kimberley acted as the focus for each line, the actual route adopted was governed by the physique of the country. Thus the line from Cape Town followed the Great Berg valley to Gouda, took advantage of Roodezand pass to reach the Breede valley and utilized the Hex river valley and pass to cross the

main mountain barrier to Touws river. This circuitous route not only afforded the easiest gradients over the Cape mountains but also passed through the most productive and most populous country. From Touws river the railway skirted the Nieuwveld range and traversed the level country of the Great Karoo to Beaufort West, north of which a major break in the Escarpment (see ch. 1, p. 24 and Fig. 11) gave access to the Upper Karoo. The main line from Port Elizabeth followed the Great Fish river valley and negotiated the Escarpment between the Sneeuwberg and the Kikvorschberg while the East London line took advantage of the pass created by the headwaters of the Kei and Stormberg rivers between the Bamboesberg and the Stormberg.

Once the railways had been carried over the Cape mountains and the Great Escarpment, progress was rapid. The Cape Town line reached Kimberley in 1885. The Port Elizabeth line reached Colesberg in 1883 and the East London line Burghersdorp in 1885. Here, however, they were held up pending an agreement between the governments of the Cape and the Orange Free State over their extension across the latter territory. This prompted the linkage of the Port Elizabeth line to that from Cape Town at De Aar. Meanwhile the Durban line which had to be carried across the complex mountainous country of the Valley of a Thousand Hills and the outer spurs of the Escarpment, made slow progress and only reached Estcourt in 1885.

With the discovery of the Witwatersrand goldfield in 1886 the target of railway construction shifted to the Transvaal, thereby bringing about a change in the relative potentialities of the ports with regard to the inland trade. Port Elizabeth and East London lay nearer the Witwatersrand than Cape Town but the shortest route from each had to pass through the Orange Free State. The distance from Durban to the Witwatersrand was less than from any of the Cape ports and that from Lourenço Marques in Portuguese territory still less. In both cases lines could be carried to the Transvaal border without crossing other territories. Immediately political considerations assumed a dominant role in railway policy. The Orange Free State, now in a strong bargaining position and standing to gain from the development of the Witwatersrand, granted permission for the extension of the Cape railways contingent upon the conclusion of a customs union between the two states. But the Transvaal held the trump cards. In 1892 the eastern Cape line was carried across the Transvaal border and extended to Germiston, where it linked up with the Rand line, built between 1890 and 1891, but a stiff customs barrier was erected at the border and provision made for the handing over of the line to the Transvaal government at an early date. The Cape Town line reached Fourteen Streams in 1892 but was not linked with the Transvaal system until 1897. The Natal line reached the Transvaal border at Volksrust in 1891 but its extension was held up pending the completion of the line from Pretoria to Lourenço Marques commissioned by the Transvaal government. Once completed the latter line would by reason of the much shorter haul easily compete with the Cape ports for the heavy traffic. The Durban line served by a port with facilities

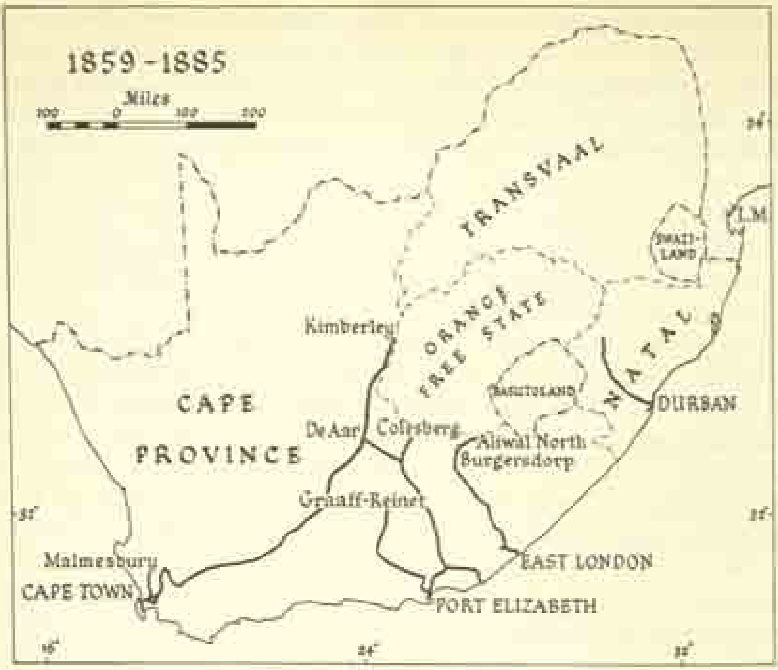


Fig. 169a

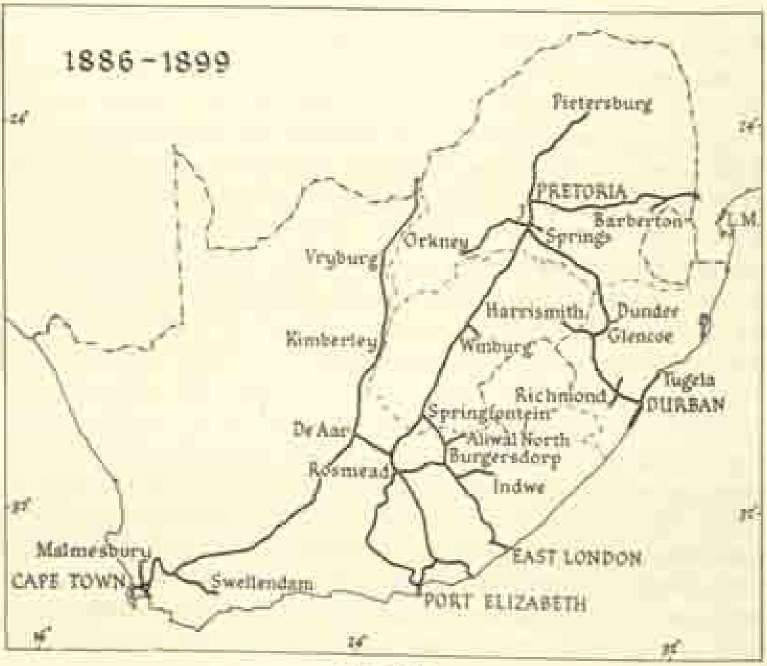


Fig. 169b

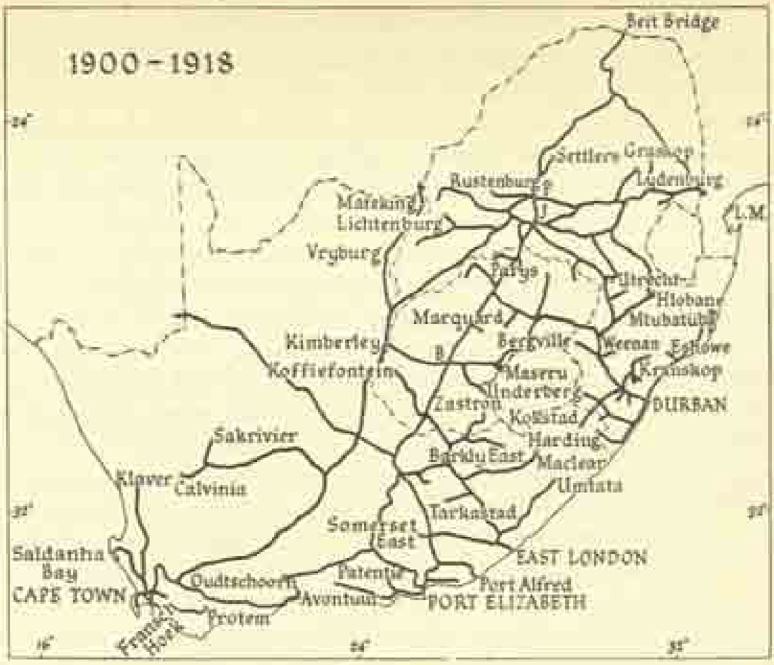


Fig. 169c.

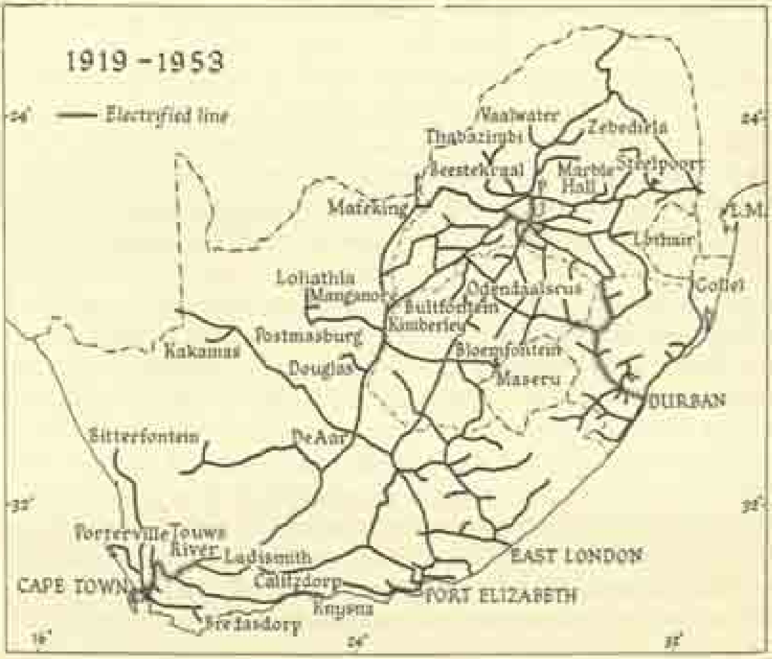


Fig. 169d.

Fig. 169a–d. The growth of the railway network of the Union of South Africa, 1859–1953.

(Compiled from information contained in the annual reports of the South African Railways and Harbours Administration.)

superior to those of Lourenço Marques however threatened serious competition. But, hampered by disease and floods in the Lowveld, the construction of the Lourenço Marques line was not completed until 1894. Next year permission was granted for the extension of the Natal line on condition that Natal would never carry goods at a lower rate for the whole distance than the Delagoa Bay line. Natal was also obliged to reduce the customs duty charge on traffic in transit to the Transvaal. With the completion of all the lines competition became acute. The Cape stood to lose most and strove for an apportionment of the traffic, but the Transvaal held the whip hand and by charging artificial rates on those portions of the Cape and Natal lines within her territory, could direct the flow of traffic; her main aim being to obtain as much traffic for her own line as possible. The Cape railways which hitherto had been the main source of revenue in the Colony and the Natal line increasingly suffered from the competition of the Delagoa Bay line. Their tonnage of through traffic declined and receipts fell. At the outbreak of the Anglo-Boer war the competition between the various lines had reduced the finances of the Cape Colony to a ruinous state. Meanwhile it had prevented the efficient operation of the main lines and discouraged the construction of branch lines. Short lines were built to Swellendam in the Cape, into the sugar belt and into the Midlands of Natal but the only major line undertaken was in the Transvaal, i.e. that northwards from Pretoria towards the copper-mining area of Messina; this reached Pietersburg in 1899.

With the Peace of Vereeniging other considerations came into play. The Cape Colony and Natal set about strengthening their trunk line systems with a view to increasing their competitive power and also began constructing branch lines to serve the agricultural areas. In the Cape branch lines were built into the wheat lands around Caledon and Malmesbury and into the irrigable belt of the Little Karoo and the Long Kloof. In Natal the lines serving the sugar belt and the wattle and mixed farming areas around Pietermaritzburg were extended while a new line was constructed from Glencoe to tap the Klip river and Vryheid coalfields. In the Orange Free State, the railways, taken over by the State after the Jameson Raid, were now amalgamated with and operated by the Transvaal Administration; the Caledon river lands were linked with Bloemfontein and thence Kimberley, respectively on the two major routes from the Cape, and to the line which was extended from Harrismith to Kroonstad thereby connecting the Natal and Cape main lines. In the Transvaal railway construction followed a different pattern, being concerned with the construction of new lines from the central node into undeveloped country with a view to facilitating its development. Thus from the Rand lines were extended eastwards towards Bethal and Carolina in the present maize belt and westwards towards Zeerust; and from Pretoria towards Rustenburg, already developing as a centre for citrus fruit production. From the northern line a branch was built into the Springbok Flats.

When the boom period which followed the cessation of hostilities came to an end in 1905, competition once more became acute between the several trunk lines

with the advantage with regard to heavy goods traffic lying with the Delagoa Bay line. This was strengthened by the fact that as part of the agreement whereby labour for the Witwatersrand gold mines was obtained from Portuguese East Africa, at least 55 per cent of the total imports of the Transvaal were to be carried by the Delagoa Bay line. The remainder of the traffic was apportioned under an agreement of 1904, the Cape railways being guaranteed 20 per cent of the total imports into the Transvaal, and the Transvaal undertaking to so regulate rates as to maintain fixed proportions of traffic between the Cape and Natal, and Delagoa Bay. This worked fairly well so long as only three main lines entered the Transvaal but when several new lines crossed the border and the coastal colonies changed their routes to take advantage of them, it became exceedingly difficult. Moreover, in the Cape, Port Elizabeth and East London continued to compete uneconomically for a share of the heavy goods traffic. With increasing realization of the importance of railways to development in all states, the need for agreement on technical matters such as gauge and wagon weights and the increasing difficulty of operating the several systems individually, the need for a unified system came to be appreciated, constituting a major factor hastening Union in 1910.

Following Union most attention was directed to the construction of the agricultural branch lines and connecting links, but the Pietersburg line was carried northwards to the Messina copper mines which were given also a direct outlet to Lourenço Marques by the construction of a new line from Zoemakaar to Komatipoort. The outbreak of war in 1914 brought this policy to a halt. At once materials and labour became scarce and the resources available had to be employed in building lines out into the Kalahari in order to facilitate military operations against German South West Africa. The Prieska line reached the border in 1915 while the Carnarvon line was extended to Williston. In the same year German South West Africa was conquered. The Germans had built 3 feet 6 inch gauge lines from Luderitz to Keetmanshoop and Karibib with a branch to Kalkfontein and narrow gauge lines from Swakopmund to Karibib and to Tsumeb, with branches to Grootfontein and Outjo. Private narrow gauge lines served the diamond fields north and south of Kolmanskop. The presented Germans destroyed much of the permanent way and its replacement retreating numerous difficulties. Work began on the conversion of the Tsumeb line to the 3 feet 6 inch gauge, but it was found that with the existing grades – 1 in 19 and 1 in 20 – and with slippery rails caused by the heavy fogs which hang over the coastal strip, engines sufficiently powerful to negotiate the Escarpment with reasonable loads were too heavy for the track; pending regrading, recourse had to be made to mules over the difficult sections. Gradually, however, the lines were regraded and relaid and linked with those of the Union and suitable locomotives procured for their operation. Since then there has been no new major construction in the territory.

After the first world war the elaboration of the railway network took the form

of the extension of agricultural branch lines, the construction of cross connecting lines and the building of new lines to permit the exploitation of mineral wealth. In the early 1920's activity was concentrated on the maize belt in order to facilitate the export of grain while branches were built to areas of intensive irrigation farming as around Brits, Zebediela, White River, Douglas, Kakamas, and Ladismith. In the late 1920's and early 1930's mineral lines were built to permit the exploitation of the chrome ore of the Steelpoort area, the iron ores of Thabazimbi, the manganese ore of Postmasburg and Lohathla and the limestone of Marble Hall, in each case the line being guaranteed against loss by the mining company concerned. Since the second world war the only new lines have been in connexion with mineral developments – to Odendaalsrus in the Free State Goldfield, to the new mines in the southern part of the Witbank coalfield, and to the new Grootvlei colliery supplying the Klip river power station.

Thus the backbone of the South African railway system was laid during the period 1870 to 1900 and the years between 1900 and 1914 saw the building of connecting links and branch lines. Since 1918 the system has been further elaborated but most attention has been directed towards the improvement of facilities by regrading, relaying heavy rails, track doubling and electrification, provision of new goods yards and stations, improvement of port facilities consonant with the ever increasing volume of traffic associated with the country's continually expanding economy.

The Growth of Traffic and Improvement of Facilities

With the growth of rail traffic consequent on the general economic development of the country the difficulties associated with the nature of the terrain traversed and intensified by the orientation of the initial system became increasingly apparent.

The great distances coupled with the unfortunate convergence towards Kimberley, the first goal of railway development, burdened the country with long stretches of line through unproductive arid country. In many places the provision of locomotive water has presented serious difficulties. In the Transvaal and Natal, where surface water is plentiful and the railways have the right to expropriate water, the needs have been relatively easily met by the construction of dams on the rivers. The Eastern Transvaal system, for example, is supplied from a dam holding 36 million gallons built across the Olifants river near Belfast in 1920. Over much of the Cape and the Free State, however, surface water is lacking and the Railways do not have expropriation rights. Here small reservoirs fed either from boreholes or by water taken out of the major rivers, have had to be built at frequent intervals. The borehole water, however, is highly alkaline (see ch. 7). It must be treated before use and even then so fouls the boilers of locomotives that the latter have to be stopped at frequent intervals for cleansing. In the drier areas the river supply is uncertain and in years of drought may fail completely. In 1919 for example, supplies gave out at Springfontein and Molteno, the Modder river

dried up and the Vaal river at Fourteen Streams ceased to flow; special water trains had to be run in order to maintain services. Supplies have since improved but with increasing traffic the water problem particularly between Touws river and Kimberley has become more difficult. Various means of overcoming it have been tried – wider tube spacings in the standard locomotives to permit larger runs between wash-outs in bad water areas, the employment since 1951 of special locomotives with condensing tenders, which reduce water consumption to one-tenth that of ordinary steam locomotives, and electric traction. All have meant larger and heavier locomotives, necessitating the strengthening of rails and bridges and the easing of gradients.

The bridging of rivers presents serious difficulties in many parts of the country and particularly in the eastern coastal belt where lines paralleling the coast must be carried across a large number of major rivers which occupy wide and deep gorges in the hilly country and then enter the sea via wide lagoons. Since all these rivers become swollen after heavy rains, high level bridges are essential; even these may be swept away during heavy floods. At first light timber bridges were constructed over most streams but as locomotive and train loads became heavier the strengthening or replacement of old bridges became necessary. Because of the constructional difficulties and expense involved progress has been slow. On the Umtata line, which carries little remunerative traffic, when the old low level timber bridge across the Great Kei river was destroyed in 1918, the road bridge was converted for joint rail and road use. It was not until 1947 that work began on a new railway bridge which was completed in 1949. In the Natal coastal area the construction of bridges across the mouths of the rivers has been hampered by high tides and gales; largely because of this the Umkomaas bridge which is 730 feet long took five years to build, being finally opened to traffic in 1948. On the Pretoria–Lourenço Marques line floods in the Crocodile valley have repeatedly damaged or destroyed the bridges between Machadadorp and Ressano Garcia, and similar destruction has occurred from time to time in the Sundays and Great Fish river valleys.

Despite the existence of gaps and passes the Great Escarpment has always presented difficulties to railway engineers and has necessitated steep ruling gradients on the main lines from the ports to the interior. Originally the main lines from the three Cape ports were built to maximum ruling gradients of 1 in 40 uncompensated for curvature, while the very severe ruling gradient of 1 in 30, which approaches the limit for economical and practical adhesion working was adopted for the Natal line. The Lourenço Marques line was built to a ruling gradient of 1 in 50 but a short rack section between Waterval Onder and Waterval Boven was necessary in order to scale the Drakensberg Escarpment. On all the main lines banking engines had to be used to assist trains up the steepest gradients while the light rails used – 60 lb. in weight – limited the load carried. As the traffic increased heavier trains pulled by more powerful and heavier locomotives became essential, necessitating easing the stiffest gradients and relaying the lines

with heavier rails. The rack section on the Lourenço Marques line was eliminated just before Union and thereafter the work of regrading and relaying the main lines went ahead. To date the ruling gradient on the Natal line has been reduced to 1 in 50 and long lengths on the three Cape lines to 1 in 50 or 1 in 66; but unimproved sections on the 1 in 40 scale remain. Recently, a major project involving an 8 mile long tunnel through the Hex River Mountains has been completed on the Cape Town–Kimberley line. This has shortened the route by nearly 5 miles, saved curvature to the extent of thirteen complete circles and, most important, obviated the necessity for stationing banking engines and crews at De Doorns station for the sole purpose of assisting trains up the mountains. The need for banking engines between Touws river and Prince Albert Road was obviated by easing the gradients in 1915 and on the Natal line it was eliminated by the changeover to electric traction in 1928. Thus gradually engineering skill is overcoming the physical barrier of the Great Escarpment, albeit at great cost.

Because of the nature of the country and the great distances from the ports to the interior, the railways were originally laid down as single track lines. When the traffic increased rapidly after the first world war congestion became acute on all the main lines and especially on the Natal line which was called upon to carry increasing quantities of coal to Durban for bunker and export purposes. At the same time supplies of locomotive fuel became a problem at the ports far removed from the coalfields. The difficulties were accentuated by the low speeds of trains consequent on the stiff gradients over the Escarpment. According to the local conditions attempts were made to ease the congestion either by doubling the track or introducing electric traction – the former in suburban areas and in open level terrain where railroad construction was relatively easy, the latter where greater and more efficient tractive power was necessary for haulage up steep gradients. Where congestion was particularly acute both expedients were adopted. During the war additional lines were laid to ease the congestion on the passenger services in the Cape Peninsula and on the Witwatersrand and to aid the coal traffic from the Witbank coalfield. The first major electrification project was on the Natal main line. In 1922 work began on the section between Pietermaritzburg and Glencoe where a rise of over 2,000 feet in 175 route miles presented one of the most difficult sections negotiated by the South African Railways. At the same time the track was doubled for some 25 miles inland from Durban and also between Wallsend and Glencoe Junction. In 1926 electric traction was inaugurated and the resulting speed-up in traffic movement was such that within a short time the tonnage carried nearly doubled. In 1928 the Cape Town–Simonstown line was electrified in order to speed up the suburban traffic flow. The electrification of the Durban–Pietermaritzburg section of the Natal main line was also considered but with the onset of the World Depression, the anticipated increase of traffic did not materialize and the project was shelved.

Rail traffic declined during the early 1930's (Fig. 170) but with increased gold mining activity following the departure from the Gold Standard, the rise of

the iron and steel industry and the growth of secondary industry, and the development of an export trade in certain agricultural commodities, it began to recover in 1934. Meanwhile engineering advances had halved the cost of electrification. Consequently when in 1934, traffic began to increase again the electrification of the line between Daimana and Harrismith over Van Reenen's Pass, where steep gradients had presented difficulties to steam locomotives, was put in hand and in the next year work began on the electrification of the Randfontein–Springs and Johannesburg–Pretoria lines and on the Durban–Pietermaritzburg and Glencoe–Volksrust sections of the Natal main line. At the same time the doubling of the Natal line was carried a further 24½ miles to Umlaas Road, the work necessitating the twinning of ten tunnels through the difficult country of the Valley of a Thousand Hills. All these projects were completed by 1938 but meanwhile the growth of the coal traffic following the development of electricity generation, and of inland ore movement connected with the rise of the iron and steel industry, the increased export of such agricultural products as maize and fruits and the development of an export trade in bulky minerals, particularly manganese and chrome ores, had brought such an increase in the freight offering that it exceeded the carrying capacity of the railways; congestion and delays ensued. By now the major problem was a shortage of rolling stock at a time when overseas suppliers on whom South Africa largely depended were curtailing their output and concentrating on armaments. The shortage was the more acute as the rail traffic was increasingly of a nature requiring special wagons – fruit requiring refrigerated wagons with racks, milk refrigerated tankers, ores either hopper or dropsided wagons and petrol special tank wagons. In addition large numbers of cattle and sheep wagons had to be maintained for conveying drought-stricken stock to new pasturage in years of poor rains. Because of their special nature many wagons had to make the journey in one direction empty. When the second world war broke out in 1939 South Africa was already suffering from an acute shortage of both wagons and locomotives.

During the war shortages of materials and of man-power brought work on large-scale development projects to a standstill. But with the increased demand for coal at the ports, the expansion of the iron and steel industry and the growth of manufacturing, the freight traffic continued to expand while passenger traffic increased very rapidly (Figs. 170 and 171). Wagon production was stepped up in the railway workshops and was started in private factories; the building of shunting engines began in the railway workshops at Salt River in 1943. The output, however, fell far short of the requirements. In consequence the railways were quite unprepared to cope with the unprecedented volume of traffic they were called upon to carry in the post-war years when the development of the Free State Goldfield, the enormous expansion of industry in the southern Transvaal, the overseas demand for foodstuffs and mineral ores, and the import of urgently needed heavy machinery, equipment and consumer goods, brought demands for the movement of very varied and in some cases highly exacting

commodities over great distances of country. To the difficulties arising from the inadequacies of the lines and shortages of wagons and locomotives were added the inadequacy of handling and storage facilities at the ports (see pp. 498–512) which delayed the turn round of wagons. As soon as hostilities ceased measures were taken to re-equip the railways and improve the facilities. Major construction projects designed to speed up movements from the ports, alleviate congestion in the southern Transvaal and provide for the increasing traffic to the Free State

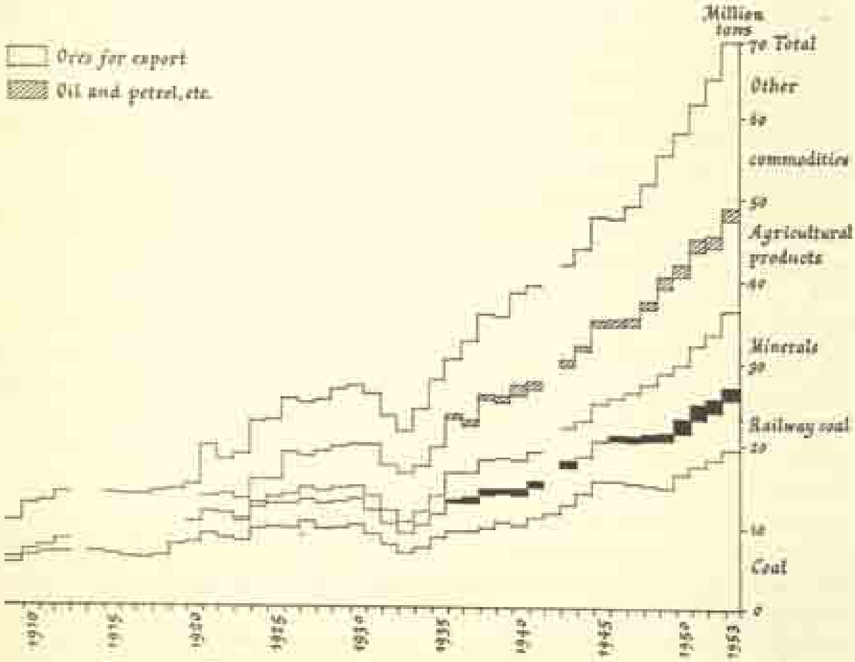


Fig. 170. The growth of the railway freight traffic, 1910–53.

goldfields were initiated. They comprised the construction of new lines, and the doubling and/or electrification of others, the easing of gradients and the building of new stations, workshops and marshalling yards.

While the harbour facilities at the major ports had been extended over a period of years (see pp. 498–506) the provision of additional facilities for the receipt and despatch of goods by rail had lagged behind. After the war the ports were able to handle the additional seaborne traffic but lack of storage space and delays in the despatch of goods inland resulted in severe congestion. In order to ease the position at Port Elizabeth the construction of new marshalling yards was put in hand and work began on reducing the gradients and eliminating the sharp curves on the main line between the city and Cradock, so as to permit an increase in train loads from 450 to 720 tons and thereby speed up transit. A major project

for easing the gradients between Cape Town and De Aar was also started but in order to effect a more immediate improvement in the carrying capacity of the line its electrification to Touws river was undertaken and completed in 1954. At the same time the line was doubled to Wellington and new marshalling yards provided at Worcester, Touws River, Beaufort West, and De Aar. At Cape Town a new station and a new goods lay-out were constructed as part of the Foreshore development plan (see p. 501). In order to increase the carrying capacity of the

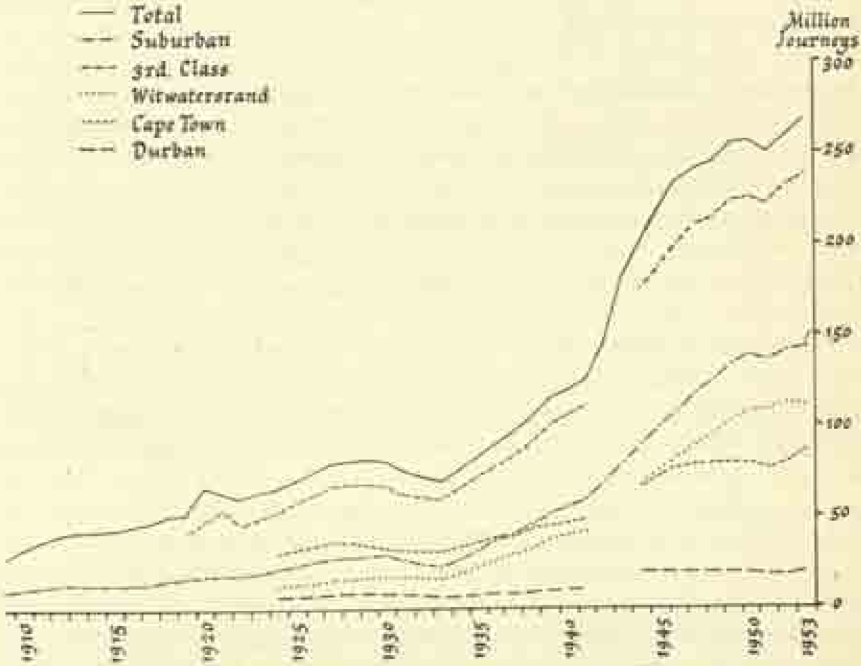


Fig. 171. The growth of the railway passenger traffic, 1910–53.

Durban line track doubling between Pietermaritzburg and Ladysmith was put in hand while work began on new goods and passenger facilities in the reclaimed bayhead area.

In the southern Transvaal congestion had arisen because the coal and ore traffic to the iron and steel works at Pretoria and Vereeniging had to pass through congested sections of the Rand system while the facilities for goods and passenger traffic were totally inadequate to cope with the heavily increased demands made upon them as a result of industrialization on the Rand. The inadequacy of the goods depot at Kazerne (Johannesburg) was recognized in 1936 and two years later work began on a new site south-east of the city, adjacent to the Rand mineral line, and within the industrial belt. The war interrupted the project but work recommenced in 1945 and the new depot equipped with mechanical handling devices and boasting a forwarding shed covering 12 acres with the largest single

concrete roof in the world, was opened in 1951. At the same time a central marshalling yard with a mechanized 'hump' was completed at Angelo to the east of Johannesburg. Thus traffic is now collected at and distributed from a point outside the congested belt. New lines from Union Junction to Vereeniging and from Rangeview to Natalspruit take the coal traffic direct to Vereeniging and points south and west. Only traffic for the abattoirs and wholesale markets and for private sidings is now dealt with at Kazerne. At Vereeniging, where the goods traffic doubled between 1947 and 1952, a scheme comprising new marshalling yards and locomotive depot, a new station and a new bridge over the Vaal river, is in hand. In an attempt to deal with the increasing passenger traffic on the Witwatersrand, Johannesburg station was completely rebuilt and enlarged between 1946 and 1951. In spite of these improvements, however, the transport facilities for African workers travelling between the western and south-western Native townships and the industrial belt along the Reef railway are totally inadequate and acute congestion prevails. Here additional lines and additional trains are an urgent necessity.

Between 1942 and 1952 the total goods carrying capacity of the railways was increased by 79 per cent; over 33,000 new wagons were placed in service, over 18,000 of them coming from Union workshops. Over 900 new passenger coaches were bought, more than half of them from Union workshops. The number still fell short of needs, however, largely because of the difficulty of obtaining vehicles from overseas and the limitations placed on home output by a shortage of teak and other suitable timber and the inadequacy of the workshop facilities. More serious, during the same period the tractive force of the steam locomotives was increased by only 17 per cent, the lag being due to dependence on overseas producers who were unable to meet all their orders and give early deliveries. In order to ease the position by increasing the home output of wagons and coaches and providing additional facilities for the overhaul and repair of locomotives the existing railway workshops are being considerably enlarged and new ones created. Each workshop is situated strategically for the type of work undertaken. Thus heavy locomotive repairs are carried out at Pretoria, Pietermaritzburg, and Salt River (Cape Town) each occupying a nodal position with regard to both trunk and local lines; coach and wagon building is concentrated at Germiston and Pretoria, which are conveniently situated for obtaining iron and steel from the Iscor works and timber from the eastern Transvaal or overseas via Lourenço Marques; the manufacture of points and crossings and the repair of the permanent way is undertaken at Bloemfontein, while repairs to port handling appliances and to the railways floating craft are effected at the coastal workshops. The most important new development is the construction of a new workshop, destined to rank among the largest in the world, at Koedoespoort, nine miles east of Pretoria, to take over and extend the work hitherto undertaken at the workshops near the city centre, where there is insufficient room for expansion, and thereby speed up the overhaul and repair of locomotives.

While efforts are thus being made to increase the carrying capacity of the railways and alleviate the congestion, many difficulties remain. To some extent this stems from the nature of the traffic offering.

The Nature of the Traffic and the Rating Policies

At the time of the Union the freight traffic consisted very largely of supplies for the diamond and gold mining centres. Coal was also carried from the Natal coal-fields to Durban for bunkering. The passenger services were patronized by the more wealthy Europeans travelling between the mining centres and the ports. Generally speaking both freight and passenger traffic was highly profitable. After the first world war the general economic development of the country brought an ever increasing volume of traffic, and a marked change in its character. Increasingly the freight traffic consisted of bulky commodities, particularly coal, and agricultural products, and after 1935 mineral ores. This trend became even more marked during and after the second world war when the growth of industry in the southern Transvaal was accompanied by the long distance movement of raw materials but not of manufactured goods, most of which were consumed locally. Thus today the major part of the freight traffic consists of bulky commodities of low value which can bear only low freight rates. At the same time valuable commodities such as gold and diamonds are now carried by air.

The major part of the freight traffic either originates in or is destined for the Transvaal for which Lourenço Marques and Durban are the nearest ports. But in order to avoid congestion at these ports and on the railways feeding them and at the same time maintain the Cape ports, which naturally serve more restricted hinterlands, as fully equipped modern ports, it has been necessary to distribute the Transvaal traffic between all the major ports of Southern Africa. The actual movement of traffic has been greatly influenced by the rating policies adopted both with regard to individual commodities and to particular ports. To this extent it may be said to be artificially controlled.

As in most countries the railway rates have been fixed according to the principle of 'what the traffic will bear'. The basic system was determined in 1912 and was revised and simplified in 1920. Thereafter, apart from minor modifications made necessary by changing economic circumstances, no changes were effected until 1954. Prior to the second world war, it was necessary, in the interests of the national economy, to accord special low rates to certain commodities. Thus to reduce the use of wood as fuel in the Cape and to permit the use of South African coal for bunker purposes at Cape Town low and tapering rates were necessary on coal. Oil has largely replaced coal for bunkering but low rates on coal have been maintained in order to supply cheap fuel to the electric power stations. Special rates for maize and fruit were necessary during the inter-war period in order to enable South African producers to compete in overseas markets, low rates on wool became necessary after the Great Depression while fertilizers and agricultural supplies were carried cheaply in an attempt to improve

the agriculture of the country. In order to save farmers from ruin in years of severe drought, drought-stricken stock were carried at very low rates to new pasturage. In the 1930's special rates were accorded South African iron and steel in order to stimulate the growth of the Union's iron and steel industry. Much of the coal traffic and the agricultural traffic was unremunerative or actually carried at a loss. In addition further revenue was lost by the operation of 'nearest port rates', whereby, in order to promote the growth of industry in inland centres, the cost of freight between factory and consumer did not exceed that from the nearest port to the consumer. Moreover, further unremunerative traffic was carried between the ports at 'sea competitive rates' introduced in order to enable the railways to compete with coastal shipping which after discharging cargo was prepared to carry cargo at very low rates rather than travel coastwise with empty holds. In order to make the railways pay it was necessary to impose high rates on other goods, particularly supplies for the mines, machinery and imported consumer goods. Thus, in effect the railway rating policy was used as a means of taxing the mining industry and the consuming public in order to support agriculture and stimulate the development of industry. So long as the country remained undeveloped this policy was perhaps justified. But after 1935 the country developed rapidly, and the railways were called upon to carry increasing tonnages of coal, mineral ores, both for export and internal consumption, as well as agricultural produce and general goods. Most of the increased tonnage was of low-rated traffic. Because of the high proportion of bulky goods of low value, and of the vast distances over which they had to be conveyed, and the granting of preferential and special rates, the disparity between the revenue yielded by the high and the low-rated traffic became very great. In 1938, exclusive of coal, the low-rated traffic contributed only 12 per cent of the revenue per 1,000 tons and only 13 per cent of the revenue per 1,000 ton miles whereas in Great Britain the corresponding contributions were 22 and 32 per cent respectively. After the war the disparity became even greater. By now agriculture had been placed on a sound footing, large profits accrued from the sale of wool, fruits and in some years of maize. Heavy industry was firmly established. On the other hand the gold mining industry was entering a new developmental stage and light industries were struggling for establishment both at the coast and in the interior of the country. The position had changed. Moreover with the development of industry the nearest port rates gave the inland manufacturer an advantage over the manufacturer in the coastal zone. The sea competitive rates were available to commodities unsuited to conveyance by ship and tended to favour factories situated in the ports at the expense of those a short distance from them. Congestion on the railways made the carriage by sea of those commodities suited to this form of transport desirable. Following pressure from the Board of Trade and leading industrialists, a commission was appointed in 1947 to inquire into the railway rating policy of the country. Some of the recommendations contained in its report[1] published in 1950 were implemented when new tariff books were

introduced in 1954. Apart from all round increases in freight charges and passenger fares, the goods classification was revised and sea competitive rates, nearest port rates, distributive rates, preferential rates, maximum rates, milling-in-transit rates, and branch-line rates abolished. These changes will probably eliminate much of the uneconomic traffic but major changes in the flow of traffic are unlikely.

The problems associated with the passenger traffic are more difficult. The development of industry on the Witwatersrand, in Cape Town, and Durban, has brought a great increase in the suburban traffic in these areas. The passengers are mainly Non-Europeans travelling third class (see Fig. 170) at fares which are uneconomic. With the re-location of the Non-European townships on the periphery of the towns, the distances involved in the journey to work are becoming greater, while the fares cannot be raised sufficiently to cover the increased cost. At the same time since Europeans travel mainly by car or bus, the losses cannot be offset by revenue from second and first class fares.

Roads

South Africa has an extensive network of roads but few good roads. Apart from the streets of the big towns, only the trunk roads linking Johannesburg with Durban, Cape Town, and Lourenço Marques, the coast road from Durban to Port Elizabeth and Cape Town, part of the great North road from Pretoria to Beit Bridge and short sections along the main roads out of the major towns have a tarmacadamized surface. Altogether there were in 1953 only 3,386 miles of tarred surface on the trunk roads in the Union, most of it completed since 1945, when a National Roads building programme was launched. Only ten years ago there were still large stretches of gravel on the main roads from Johannesburg to Durban and Cape Town. Today the more important roads in most parts of the country and the new roads in the Protectorates have an all-weather surface, usually of gravel which, however, tends to be thrown up into corrugations, which are both hard to ride and dangerous after long dry periods with heavy traffic. The remaining roads are unsurfaced, are usually impassable after rains and tend to become very sandy and dusty in dry weather.

Two factors are largely responsible for the poor state of the roads. Until the Sasol oil-from-coal project came into production tar and bitumen for road making had to be imported and the cost of tarring long stretches of road was necessarily high. Moreover, with a well-developed railway system whose economic operation depended on the carriage of valuable commodities at high freight rates as well as low-rated bulk goods, the Government was reluctant to invest large sums in building good trunk roads.

The trunk roads of South Africa are used mainly by private motorists and even today carry relatively little goods traffic. The competition between the railways and the road hauliers which is characteristic of most countries is absent, for when the road hauliers threatened to capture the more remunerative traffic

from the railways the Motor Carriers Transportation Act of 1930 was passed, bringing the transport of goods by road under control. Since then the policy has been to develop road haulage services as ancillary services to the railways. The Railways Administration operates road motor services for passengers and goods between outlying districts and the nearest railhead. In 1956 they had a fleet of over 400 passenger vehicles, nearly 900 goods and dual purpose vehicles, mostly exceeding 10 tons weight, over 1,100 trailers, including 3 of over 45 tons, and over 100 semi-trailers, and special water, cream and petrol tankers. Over 500,000 tons of grain, nearly 170,000 tons of kraal manure and fertilizers, 135,000 tons of fruit, nearly 70,000 tons of potatoes and vegetables and over 50,000 tons of lucerne were the major items carried. As the general economic development of the country has proceeded certain areas and certain commodities have been exempted from the operation of the 1930 Act. Thus cartage contractors are allowed to operate in and around the large towns, their orbits being extended as the towns have grown. With congestion on the railways, the unrestricted conveyance of certain commodities has been permitted, in 1956 coal, coke, cement, sugar cane, grain and milled products, diesel oil, petrol, livestock, fresh fruit, and vegetables being freed temporarily. In this way the road services have been dovetailed with those of the railways and the continued economic operation of the latter, so vital for the carriage of bulky goods over long distances, safeguarded.

Airways

Separated from other economically developed countries by vast stretches of ocean, jungle and desert, with the hub of economic activities in the interior, with mining and industrial enterprises which, for financial and technological reasons must maintain close contact with associated or parent concerns in Europe and North America, and with valuable commodities such as diamonds, gold, radioactive isotopes, karakul pelts, etc., to be carried, air transport between South Africa and overseas countries is of great and increasing importance. With great distances between the main population centres air transport is likewise playing a vital role in the internal communication system of the country while with the opening up of other African territories regional services are of increasing importance.

Since the end of the second world war the growth of air traffic in South Africa has been phenomenal. In 1945 about 40,000 passengers were carried on all services – internal, regional and international – this actually representing an increase of some 3,000 over the 1938 figure. In 1955 nearly 250,000 passengers were carried, a sixfold increase in ten years. Of the total over 200,000 were carried on the internal services, three times the 1945 number, while more than 27,000 used the trunk services, a sevenfold increase over the 1945 figure; more people actually arrived in South Africa by air than by sea. At the same time there has been a marked increase in the freight traffic. Expressed in ton miles the air cargo carried on the internal services has increased from 72,000 in 1948 to over

420,000 in 1955, and that on the regional and international services respectively from 32,000 to nearly 92,000 and from nearly 330,000 to over 1,700,000 during the same period. Increasingly fresh eggs, fish and fruits are carried to the Belgian Congo and diamonds, gold, radio-active isotopes, karakul pelts and cut flowers, and delicate machinery, day-old chicks and trout ova, etc., respectively to and from overseas countries.

As in most countries, the growth of air transport has been marked by three trends, the use of faster, larger and heavier aircraft, the provision of larger airports with longer, wider and stronger runways and increasingly centralized control over services.

The development of the air services in South Africa really dates from 1934 when the South African Railway Administration assumed control, as South African Airways, of the services hitherto operated by Union Airways between Durban and Cape Town and Durban and Johannesburg. Two years later South African Airways took over all the services south of Germiston, which were previously operated by Imperial Airways; and in 1937, when the British concern introduced its flying boat service from Southampton to Durban, South African Airways took over the route from Durban to Lusaka and Kisumu jointly with Rhodesia and Nyasaland Airways. Directly after the war the Springbok service between South Africa and the U.K. was introduced under the joint operation of South African Airways and the British Overseas Airways Corporation. The service was at first weekly, using York aircraft with seating for twelve passengers, but in response to the traffic demand the frequencies were gradually increased to six per week. As this proved inadequate, in 1947 the York aircraft were replaced by larger more modern aircraft, South African Airways introducing three Skymaster Services per week and B.O.A.C. three flying boat services per week, the latter using Vaaldam, 60 miles south of Johannesburg, as its terminal. The high cost of operating the flying boat service and the continued growth of traffic encouraged the Springbok partners, in 1950, to re-equip the fleet of aircraft used on the Springbok route. Two years later they made aviation history when the first 'Comet' air liner left London to introduce the first scheduled service with jet propelled aircraft. After several disasters, however, the Comets were withdrawn, since when the Springbok service has been operated with Constellations and more recently new large Douglas aircraft, which complete the journey from London to Johannesburg in just over 21 hours. Since 1956 when Central African Airways joined the Springbok partnership they have operated a weekly service between Johannesburg and London. Some of these services are routed via Khartoum or Lydda, others via Kano. Services to Europe are operated also by K.L.M., Sabena, Scandinavian Air Lines and Qantas, the last mentioned company introducing in 1952 a fortnightly service from Sydney and Perth to Europe routed over the Indian Ocean and calling at the Cocos Islands, Mauritius and Johannesburg, this route being shorter and quicker than the route via India and the Near East. The Springbok partners, Sabena, and K.L.M. also operate

freighter services. Pan American Airlines maintain services to North America via West Africa and National Israeli Airlines to Israel. Thus South Africa is linked by air to most countries of the world. Regional services link the Union with other African territories, most important being the thrice weekly Constellation service introduced in 1956 between Johannesburg and Bulawayo. All the major centres of the Union are linked by air services, most traffic being carried between Johannesburg and Durban which have eighteen services of Constellations and

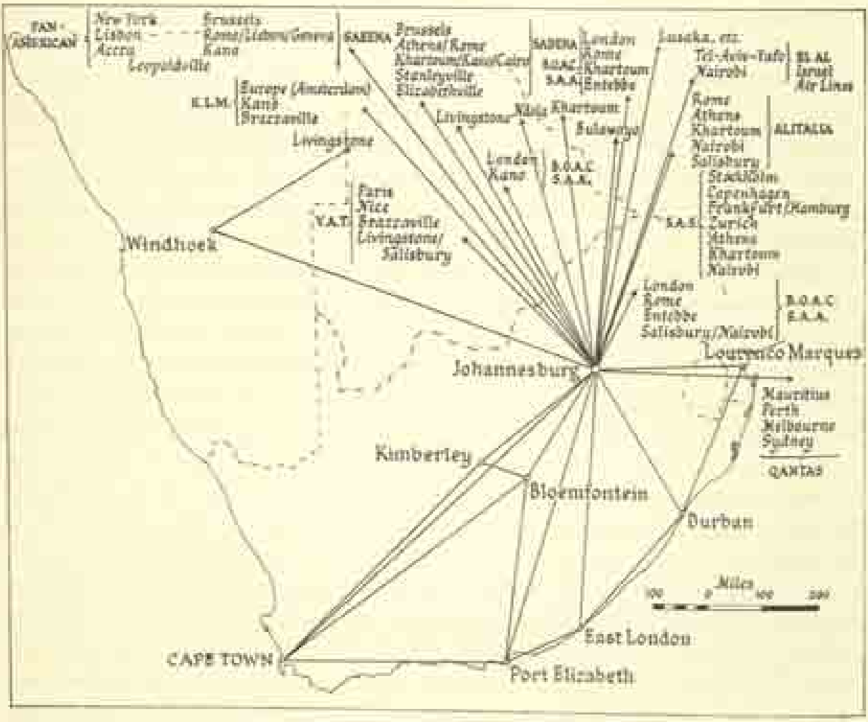


Fig. 172. Scheduled air routes, 1957.

Skymasters per week. Twelve services per week are run between Johannesburg and Cape Town. Regular services are also operated between the other centres. Johannesburg, at the hub of economic activity in the Union has naturally become the centre of the country's air services – internal, regional and international (Fig. 172).

With the growth of traffic and employment of larger aircraft the question of airports has posed a number of problems. In 1945 when the Springbok service was contemplated with aircraft which were too large to use the Rand airport at Germiston, the airport until then used by all aircraft operated by South African Airways, it was necessary to build an airport at Palmietfontein, 12 miles south of

Johannesburg, to serve as a temporary base pending the construction of a large modern international airport. Completed in 1945 the Palmietfontein airport and Wingfield aerodrome in Cape Town were at that time the only ones with hardened runways open to civil aircraft. The other aerodromes lacked hard surfaced runways and especially those in the coastal areas often became unserviceable after rain when traffic was disrupted. Aware of the unsatisfactory position the Government took steps, in 1944, to build an international airport at Kempton Park, between Johannesburg and Pretoria, and national airports at the main ports, Durban and Cape Town, and to finance the construction of hardened runways at eight municipally owned aerodromes in the more important population centres and at convenient stopping places on the main routes viz East London, Port Elizabeth, Bloemfontein, Kimberley, Windhoek, Beaufort West, Victoria West, and Pietersburg. Several considerations led to the choice of the site at Kempton Park for the Jan Smuts' international airport. It is readily accessible to the commercial and administrative centres of Johannesburg and Pretoria, it is in open country east of the quartzite ridges of the southern Transvaal and clear of the smoke laden atmosphere of the industrial zone. The airport was opened in 1953. In the same year the Durban national airport was completed and a year later Cape Town national airport was ready for use. The hardened runways have been completed at Port Elizabeth, East London, Windhoek, Bloemfontein, and Kimberley. Thus today South Africa possesses a network of all-weather airfields. In addition there are a large number of smaller public and private airfields catering for short distance unscheduled traffic. With a grand total of nearly two hundred licensed aerodromes, South Africa is overcoming the handicaps of distance and becoming increasingly air-minded.

BIBLIOGRAPHY

Most of the information on which this chapter is based has been obtained from the Annual Reports of the South African Railways and Harbours Administration from 1910 to 1956.

1. See also Report of the Committee appointed to inquire into the Railway Rating Policy in South Africa, Government Printer, Pretoria, 1950, UG 1950.

33

The Ports and their Trade

The Major Ports. Their Physical Setting and The Provision of Facilities

South Africa lacks good natural harbours and her four major ports have been very largely artificially created to serve the needs of expanding commerce. In Cape Town and Port Elizabeth dock basins have been built out into open bays. Durban and East London, respectively situated on a landlocked bay and a river estuary, owe their present facilities to constant dredging.

For more than a century Table Bay was the only important anchorage in South Africa, yet the bay afforded only limited protection before the completion of the modern harbour works. The early sailing ships found the bay difficult to enter during north-westerly gales and unapproachable during a south-easter; the anchorage afforded shelter from a south-easter but was so hard to ride during a north-wester that the ships of the Dutch East India Company used Simons Bay during the winter months. Until the latter part of the nineteenth century ships had to anchor out in the exposed bay while small boats plied between them and the land. In the 1840's Table Bay became known as the bay of wrecks.[1]

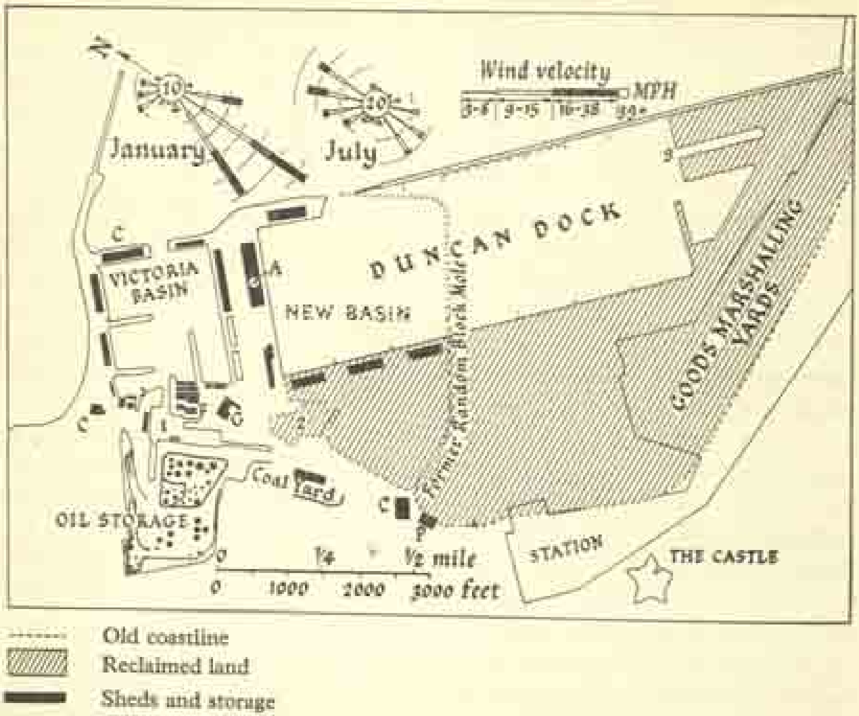
In 1860, however, work began on a breakwater and ten years later the Albert dock was opened. With the advent of steam ships bunkering facilities became necessary and in 1876 a coaling wharf was built. With the increased trade following the discovery of mineral wealth, more dock accommodation became essential; and in 1878, the breakwater was extended and next year work began on an outer harbour. This became known as the Victoria Basin while the old inner harbour became the Alfred Basin (see Fig. 173).

After the first world war the arrival of larger ships and the development of fruit and grain export trades necessitated the provision of special handling facilities (see Table 28) and made extensions to the harbour essential. Between 1924 and 1926 pre-cooling sheds for fruit were built and in 1927 a grain elevator was completed. At the same time the use of oil for bunkering ships necessitated the provision of oil storage facilities, completed in 1925. Meanwhile work went ahead on a new dock basin enclosed by a mole on the south-eastern side of the

Table 28. Port Facilities 1953

	Total Length of Completed Quayage (linear feet)	Entrance Depth to Harbour at L.W.O.S.T. (feet)	Minimum Depth at L.W.O.S.T. at Deepest Berth (feet)	Cubic Capacity of Sheds and Storage Accommodation (thousand cubic feet)	Capacity of Pre-cooling Stores (shipping tons)	Capacity of Grain Elevator (tons)	Coal Storage (tons)	Bulk Oil Storage Capacity: Petrol (thousand galls.)	Bulk Oil Storage Capacity: Paraffin (thousand galls.)	Bulk Oil Storage Capacity: Oil Fuel (tons)
Table Bay	24,680			9,210	8,300	30,000	17,000	14,937	7,107	131,100
Victoria Basin		38	37							
Duncan Dock		40	42							
Port Elizabeth			36	4,918	4,500			10,394	2,059	11,903 Th. galls.
East London		35	35	4,058	2,400			8,439	4,116	1,506 Th. galls.
Durban	29,838	42	42	8,733	1,800	42,000	70,000	201,853 tons		45,000
Mossel Bay	700	18		206						
Walvis Bay	1,500	29	29					1,485	203	4,734

existing basins. At the same time the South Arm of the Victoria Basin was widened and berthing facilities provided on its Southern Side. These works were completed in 1932.



1. Alfred basin. 2. Old fishing harbour. 3. Sturrock Graving Dock. A. Pre-cooling chamber. C. Cold store. F. New fish market. G. Grain elevator. P. Power station.

Area of wind roses represent intervals of 5 per cent. Percentage of calms shown in the centre circles.

Fig. 173. Table Bay Harbour, Cape Town.

(From maps in the annual reports of the South African Railways and Harbours Administration; wind roses based on the records of Dines anemometer at Wingfield airport, 1939–42, 1947.)

With the increasing traffic following recovery from the Great Depression and the bringing into service of larger mailships, however, it soon became clear that the New Basin would not be adequate. A plan for the redevelopment of the existing docks put forward by the Harbour Affairs Commission appointed in 1934, was rejected by the South African Railways and Harbours Administration as impracticable and eventually in 1937, it was decided to go ahead with a comprehensive scheme involving the building of a new mole from Woodstock Beach towards the South Arm return knuckle (see Fig. 173) to create a large new basin – the Duncan Dock, with a water area of 290 acres – behind which

the foreshore could be reclaimed for industrial and commercial purposes. This scheme necessitated the demolition of the mole built to enclose the New Basin, the filling in of the old fishing harbour and the provision of new fish quays in the Victoria Basin. The mole was completed in 1939 so that the Duncan Dock was ready for use during the second world war, when Cape Town became a very important port of call. The second world war, in fact, hastened the provision of berthing facilities while it brought about the construction of a large graving dock – the Sturrock graving dock. Improved dry docking facilities had been advocated since as early as 1921 but because there was unlikely to be sufficient repair work to support a graving dock, nothing was done until 1942 when the war necessitated its construction and the British Admiralty undertook to pay for the permanent machinery and equipment. The Sturrock graving dock – the largest in the southern hemisphere and able to take the largest ships afloat – was completed in 1944 and opened in 1945. It has since been equipped to take whaling factory ships. In 1956, the world's largest tanker, the 83,900-ton *Universe Leader*, was repaired there. Meanwhile new cool stores and cargo sheds have been provided and the oil storage sites extended. Thus by imaginative and costly engineering feats the naturally open Table Bay anchorage has been converted into an artificial modern harbour (see Plate 75), with the largest dock area of any port in Southern Africa, and equipped to handle all kinds of general cargo traffic, fruit traffic, and passengers.

In some ways Port Elizabeth resembles Cape Town. Beginning as the port of entry for the 1820 settlers, it has grown up on the western side of the broad, open sweep of Algoa Bay, where a little protection is afforded by Cape Recife (see Fig. 200). Situated at the mouth of the Baakens river, the port was little more than an open roadstead with three small jetties – the north jetty, now replaced by the Charl Malan quay, the south jetty, now occupied by the repair slipway, and the Dom Pedro jetty – until the construction of the breakwater and the Charl Malan quay (Fig. 174), respectively completed in 1927 and 1935. Before 1935 only ships of 12,000 tons and less were able to berth and lighterage was necessary for discharging and loading larger ships. With the opening of the Charl Malan quay the berthing of mailships became possible, while the completion of the No. 2 quay built out on reclaimed land at the head of the harbour provided additional facilities. Pre-cooling sheds have been provided on No. 2 quay, which is to be extended, while oil storage sites have been located outside the harbour area, south of the Dom Pedro jetty. Today Port Elizabeth (Plate 77) is essentially an artificial harbour, able to handle the largest ships engaged in the South African trade, while opportunities exist for a considerable extension of harbour facilities along Algoa Bay, if and when it is warranted.

By contrast East London is a river port (Plate 78), having grown up along the Buffalo river which first became important during the Border wars of the first half of the nineteenth century when a nearer port and safer anchorage than Port Elizabeth was needed to supply the garrisons around Fort Beaufort and

Kingwilliamstown. The silting of the river hampered further development and it was not until the 1870's, following the mineral discoveries, that the river was brought under control by the building of a breakwater and inner port works. The silting problem, however, has remained, necessitating continuous dredging in order to maintain a sufficient depth of water for large cargo liners. Further

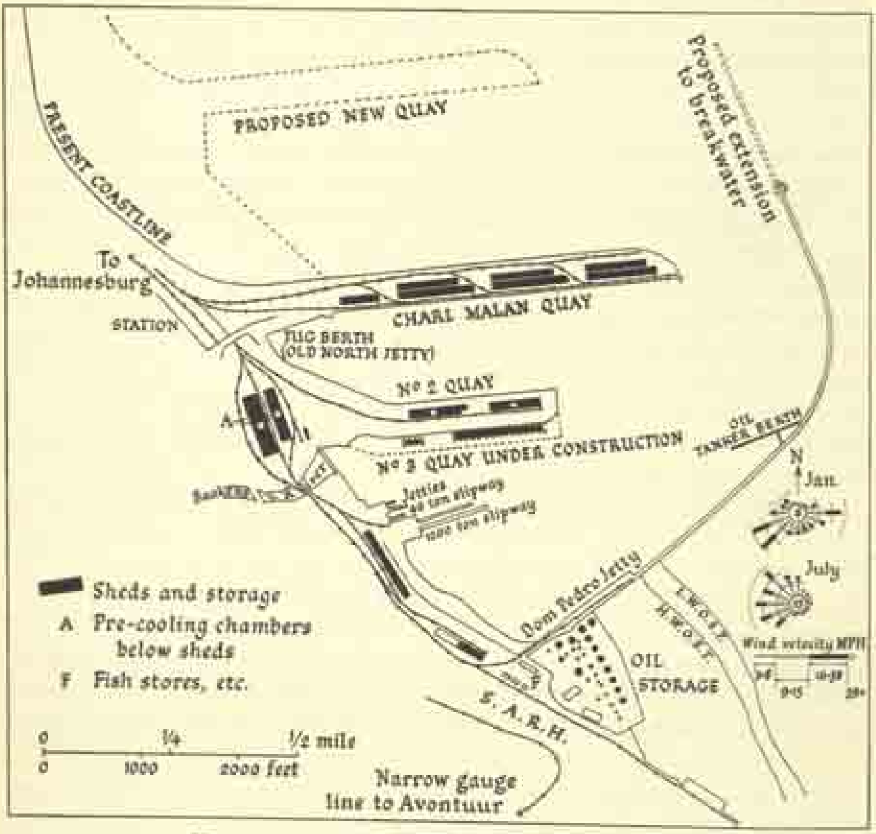
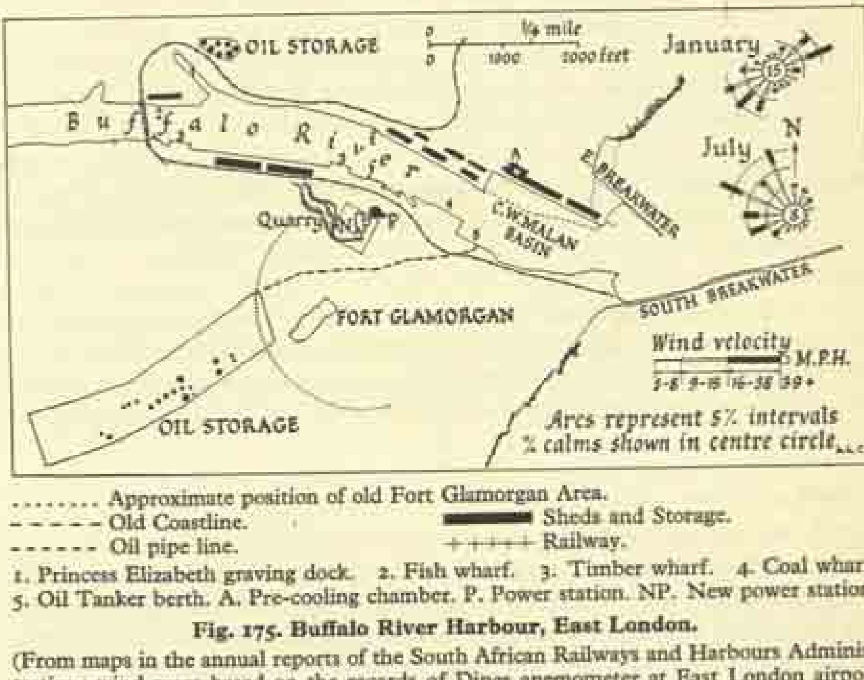


Fig. 174. Algoa Bay Harbour, Port Elizabeth.

(From maps in annual reports of South African Railways and Harbours Administration and from one supplied by the municipality; wind roses based on records of Dines anemometer at the lighthouse 1932–4, 1943–7.) Arcs of wind roses represent intervals of 5 per cent. Percentage of calms shown in centre circles.

difficulties arise from the narrowness of the river which restricts the turning of ships. During the 1930's mailships were unable to enter the port owing to the insufficient radius and depth of water in the existing turning basin. By 1938 the position had been remedied by the completion of the C. W. Malan turning basin dredged to give a depth of 35 feet at L.W.O.S.T. but as larger ships come into service East London will suffer in competition with the other major ports.

Berthing and handling facilities have been provided along both banks of the river (Fig. 175). Pre-cooling chambers for citrus and deciduous fruit were completed on the C. W. Malan quay in 1936. There are oil storage sites and bunkering facilities on both banks of the river. Before the second world war repair facilities were limited but in 1942 the British Admiralty undertook to equip a graving dock able to accommodate ships of up to 17,000 tons in order to provide facilities at a point midway between the larger graving docks at Durban and Cape Town. This dock – the Princess Elizabeth graving dock – was completed in 1947.



.... Approximate position of old Fort Glamorgan Area.
– – – – – Old Coastline.
------ Oil pipe line.
Sheds and Storage.
+++++ Railway.

1. Princess Elizabeth graving dock. 2. Fish wharf. 3. Timber wharf. 4. Coal wharf. 5. Oil Tanker berth. A. Pre-cooling chamber. P. Power station. NP. New power station.

Fig. 175. Buffalo River Harbour, East London.

(From maps in the annual reports of the South African Railways and Harbours Administration; wind roses based on the records of Dines anemometer at East London airport 1943–7.) Arcs of wind roses represent intervals of 5 per cent. Percentage of calms shown in centre circles.

The bay of Natal on which Durban stands forms the best natural harbour in the Union but partly because the Natal coast was occupied by the Bantu and partly because the mouth of the bay was dangerous to shipping, it was the last to be used by European traders and settlers. During the middle of the nineteenth century it became the port for the growing colony of Natal but it was not until the discovery of the Witwatersrand goldfields that Durban became important and serious attempts were made to provide a shipping channel.

The town and port of Durban have grown up on the northern side of the almost land-locked bay or lagoon enclosed on the southern side by the Bluff, and on the northern side by the Back Beach (see Figs. 211 and 212 and Plate 76). The

former has many of the features of a sandspit but is more than 200 feet high and covered with dense bush; the latter is only about 20 feet above sea level. Two rivers, the Umbilo and Umlatuzana, enter the head of the bay while four others, the Umgeni, Umlaas, Isipingo, and Umbogintwini rivers, formerly did so. Their combined discharge has been responsible for the gradual silting up of the bay, which today comprises mud banks, exposed at low water, divided by dredged shipping channels (Fig. 176).

The nature of the entrance between the Point, at the southern end of the Back Beach, and the Bluff has presented the main obstacle to the development of the port. The Dutch East India Company believed a reef or sand-bank to be present and feared to go in. When the bay was first used in the mid-nineteenth century the depth of the channel at the entrance averaged only 6 feet and in February 1860 it was reduced to only 1 foot.[2] This shallow depth was due essentially to the deposition of material by current action. The longshore current and the flood tidal current are both north-easterly; the ebb tide is from the north; wave fetch is from the south-east at the Bluff, changing to north-east at the Beach. The Bluff projects seawards for about 7,000 feet beyond the Point. It acts as a groyne diverting the longshore current out to sea for about a mile, when it comes back to the coast at the Beach. Leeward of the Bluff an eddy current develops; over many years the sand carried by the longshore current accumulated across the mouth of the bay, the most extensive accumulation forming the Annabella Bank. The shallow channel at the entrace to the bay was maintained only by the spring ebb tide.

The first attempt[3] to prevent the sand accumulation was the building of the old North Pier to arrest the southward drift of sand. Later when it was realized that it was necessary to increase the tidal scour a new North Pier was built at the Point, and the South Breakwater, continuing the line of the Bluff, built to the south. For a time the presence of what appeared to be a 'rock platform' straddling the bay mouth at a depth of 18 feet brought port development to a standstill. When in 1887, however, this was found to be composed of big boulders interspersed with sand which could be removed, attention was directed to dredging and increasing the tidal scour at the entrance. Because the South Breakwater projected seawards far beyond the North Pier the groyne effect continued until eventually lessened by extending the pier and reducing the projection of the breakwater to about 650 feet. Thereafter by means of a training wall directing the ebb tide into the entrance to the bay and by continuous dredging the entrance channel was gradually deepened to 37 feet. The maintenance of the depth, however, necessitated the removal by dredging of over 1 million tons of sand annually. To obviate this, an attempt was then made to defeat the longshore current by dredging a large hole in the sea-bed south of the South Breakwater and removing the sand which accumulated in it by means of dredgers to deep water, thereby depriving the current of its load. This succeeded in reducing the deposition at the harbour entrance but the southern part of the Back Beach north of the pier then

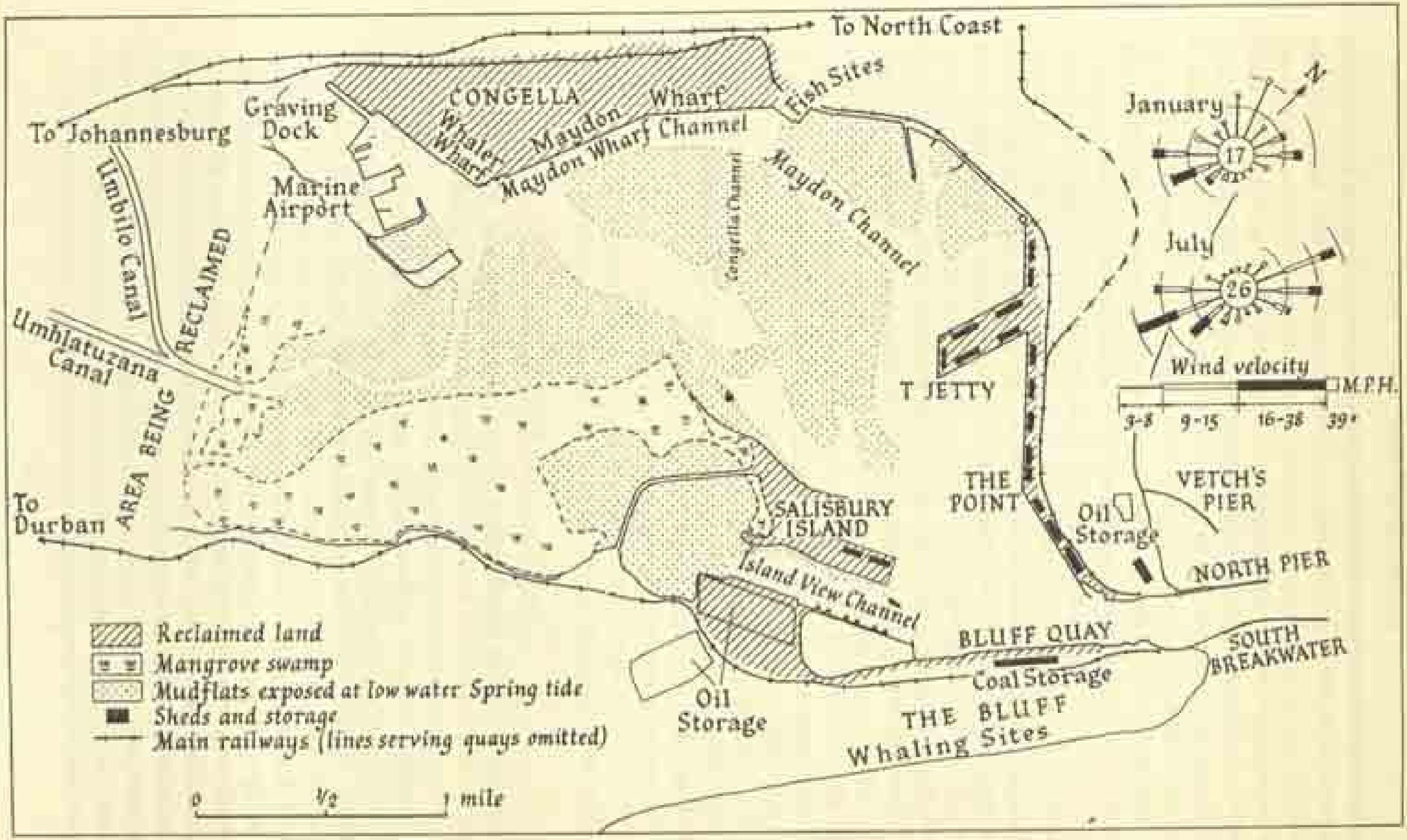


Fig. 176. Durban Harbour.

(From maps in the annual reports of the South African Railways and Harbours Administration; wind roses based on the records of Dines anemometer at Durban airport 1939–47.) Arcs of wind roses represent intervals of 5 per cent. Percentage of calms shown in centre circles.

began to disappear, much to the consternation of those concerned in the tourist industry. Thus while keeping the harbour entrance free from deposition the present problem is to regulate the drift of sand northwards to ensure that the beach, so important to holiday makers, is maintained. Here the dumping of dredged sand north of the old pier promises the solution.[4]

Today the depth of water of the harbour entrance has been increased to 42 feet. Meanwhile harbour facilities have been provided by the reclamation of the marshy bay-head area and the deepening of the approach channels. The nature of the bay has permitted the complete separation of the various types of traffic (Fig. 176). The early berths at the Point have been progressively deepened and with a minimum depth of water at L.W.O.S.T. of 42 feet can now accommodate large passenger vessels and cargo liners. Here there are pre-cooling sheds for fruit, eggs, and butter. At Maydon Wharf there are facilities for handling general cargo, grain and manganese ore. On the southern side of the bay coal storage bins and handling appliances have been installed at the Bluff where there are facilities for bunkering ships, while oil storage sites have been provided nearby at Island View. There is a whaling station outside the bay, on the southern side of the Bluff, while one berth is available for whalers at Maydon Wharf. Durban was the first Union port to have a graving dock. This was built after the first world war to meet the needs of shipping in the South Atlantic and Indian Oceans. With a length of 1,150 feet and depth of 41 feet at H.W.O.S.T. it was at the time larger than any dry dock on the American continent. During the second world war the *Ile de France* and *Mauretania* were among the ships repaired there. Adjacent to it is a floating dock completed in 1939 and the marine airport.

Thus by continuous endeavour the marshy almost landlocked bay of Port Natal has been transformed into the modern well-equipped port of Durban.

Port Rates and Port Traffic

At the time of Union South Africa was so undeveloped that apart from the export of a few items of small size and high value – gold, diamonds, ostrich feathers – her export trade was negligible and the ports depended very largely on the incoming overseas seaborne traffic destined for the Witwatersrand. The desirability of ensuring a proper spread of this traffic between the principal ports had been recognized but this could only be achieved by agreement between the Portuguese and South African Governments and by the manipulation of railway rates within the Union as the greater distances from the South African ports weighed heavily against them. In fact during the financial depression which followed the boom after the Anglo-Boer war the Transvaal firms increasingly imported through Lourenço Marques which by 1909 received nearly two-thirds of the traffic. With the coming of Union an agreement was reached whereby the Cape ports were allotted 15–20 per cent, Durban 30 per cent, and Lourenço Marques 50–55 per cent of the traffic. To divert the trade from Lourenço Marques the railway rates were adjusted in 1909, 1910, 1911, and 1912 by which time

Durban was receiving its quota but the Cape ports were not. Further adjustments were made with the aim of securing for each port the traffic for which it was most suited, e.g. Port Elizabeth, mail boat cargo, mainly fancy soft goods, East London, flour and American cargoes, Durban, heavy machinery and general goods, and Lourenço, Marques, rough traffic particularly cement, timber and iron goods. By 1924 this had largely been achieved. The proportions were confirmed by the Mozambique Convention of 1928 but with the onset of the Great Depression

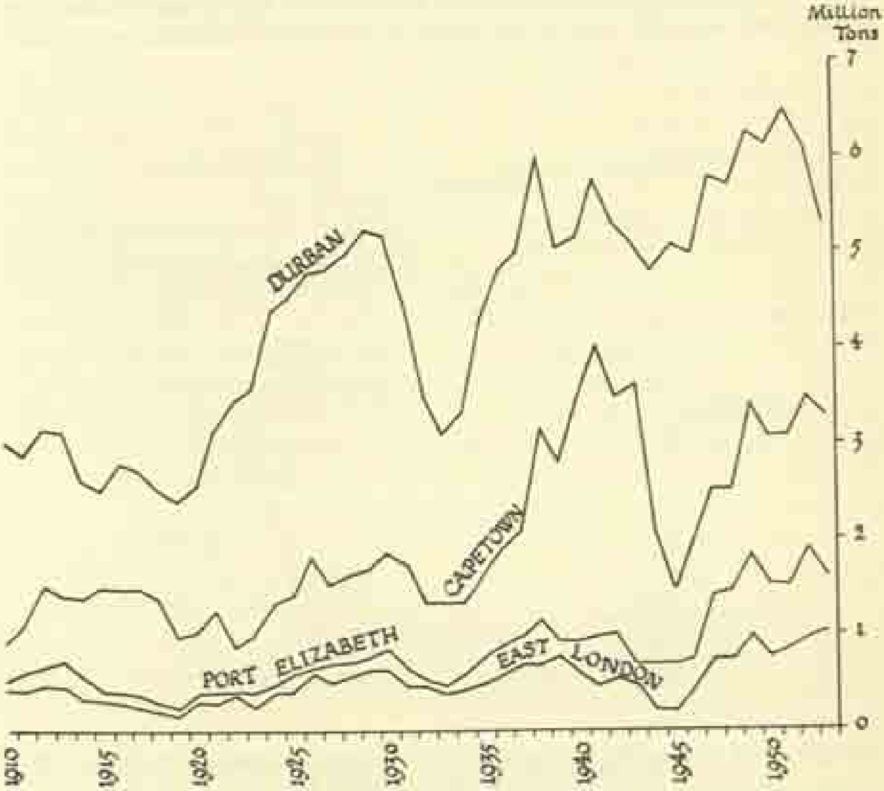


Fig. 177. The tonnage of cargo handled at the leading ports of the Union of South Africa, 1910–53.

trade contracted, particularly at Durban and in 1934 the agreement was revised so that henceforth the Union guaranteed only 47½ per cent of the Witwatersrand import traffic to Lourenço Marques. In the following year port rates on the high-rated commodities railed from Durban were decreased while those on petrol and motor spirit railed from Lourenço Marques were increased. Thus by international agreement and the manipulation of the railway rates from the ports the import traffic of the major ports of Southern Africa is largely controlled.

The export traffic which has grown with the economic development of the

country has generally been less subject to rate manipulation since it derives from all parts of the country and consists very largely of commodities which are either bulky and hence move to the nearest port or require special handling facilities and are therefore carried to the port best equipped to deal with them.

The Growth and Character of the Port Traffic

Reflecting the general economic development of South Africa the tonnage handled by all the major ports has about doubled since 1910 (Fig. 177). Both by tonnage and value the bulk of the South African trade is handled by the four

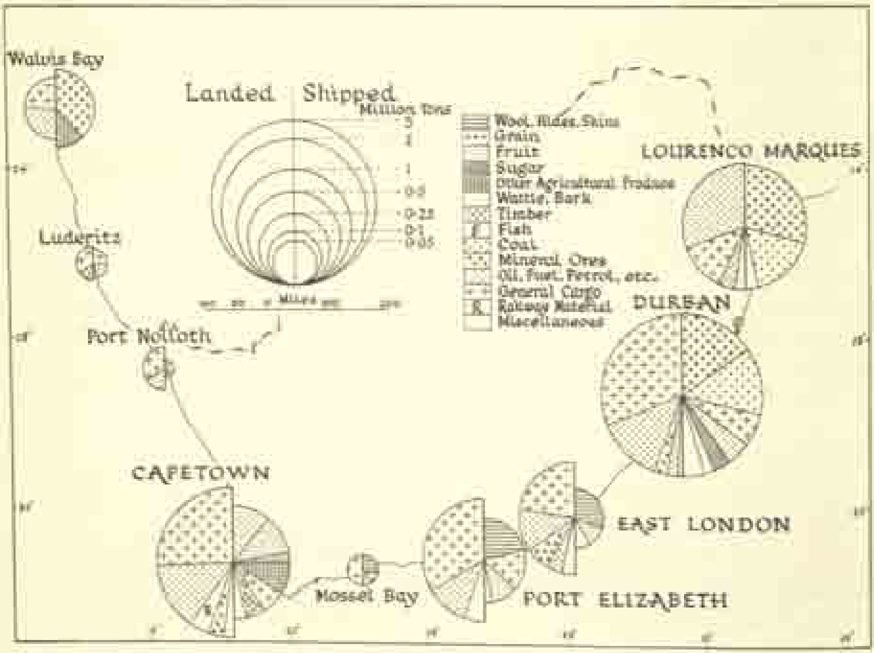


Fig. 178. Port traffic; the tonnages of the commodities landed and shipped at the South African ports during 1952–3.

(Compiled from the statistics given in the annual report of the South African Railways and Harbours for the year ended 31st March 1953, UG 50, Pretoria 1953.)

major Union ports Durban, Cape Town, Port Elizabeth, and East London, and by the Mozambique port of Lourenço Marques. The trade of Mossel Bay, Walvis Bay, Port Nolloth, and Luderitz is very small in volume and of a specialized nature (Figs. 178 and 179).

Several features of the port traffic are of striking significance. The first is the greater value of the incoming traffic compared with the outgoing (Fig. 179). This is due to the fact that the imports consist mainly of manufactured goods of high value and of fuel oil whereas the exports are mainly agricultural products and

mineral ores, the valuable exports, gold and diamonds, now being sent by air.

Second is the remarkable uniformity in the nature of the incoming traffic and the comparatively small difference in its volume between the major ports (Fig. 178). This is largely a legacy of the policy of so regulating the railway tariffs as to give all the ports a share of the goldfields traffic. Today the incoming traffic comprises mainly general cargo and fuel oil, with the main imports of the latter at Lourenço Marques, mainly for onward transport to the Rand, at Durban, both

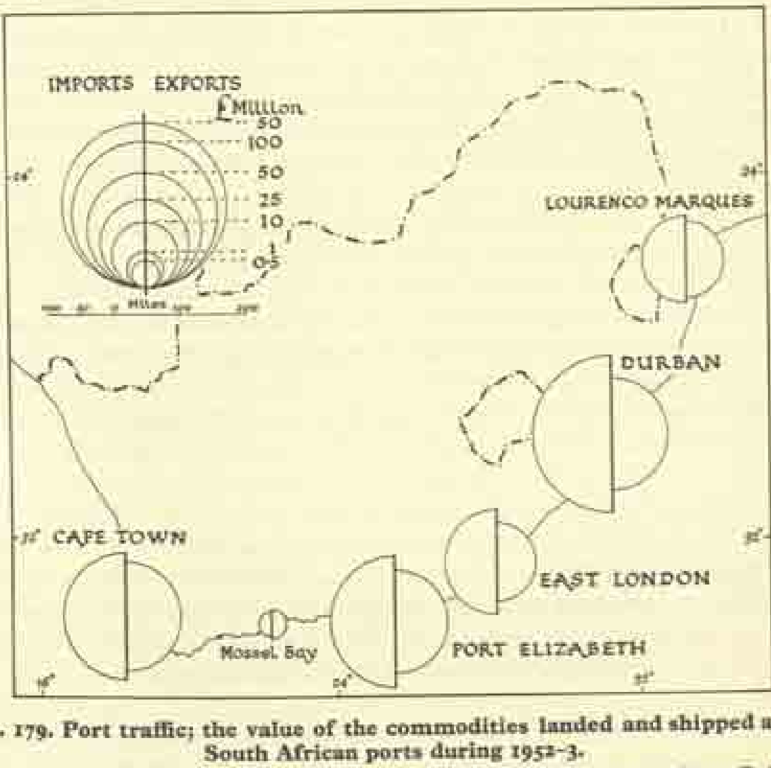


Fig. 179. Port traffic; the value of the commodities landed and shipped at the South African ports during 1952–3.

(Compiled from the statistics given in the annual report of the South African Railways and Harbours for the year ended 31st March 1953, UG 50, Pretoria, 1953.)

for internal consumption and bunkering, and at Cape Town, the principal bunkering port in Southern Africa. Bulky items such as timber are landed mainly at Durban and Lourenço Marques.

The third feature is the discrepancy between the volume of imports and of exports handled at the Cape ports, their balance at Durban and Lourenço Marques and the excess of exports over imports only at Walvis Bay. This is associated with the fourth feature, the differing nature of the export trade of the ports due mainly to the differing character of their hinterlands. Indeed the ports

might well be classified on this basis. Thus the balance of incoming and outgoing tonnage handled at Durban and Lourenço Marques is due mainly to their exports of coal from the Natal and eastern Transvaal coalfields respectively, and of mineral ores, etc., particularly manganese through Durban and chrome and asbestos through Lourenço Marques. The excess volume of exports over imports at Walvis Bay is likewise due to the export of minerals. By contrast the Cape ports export mainly agricultural produce of relatively higher value, Port Elizabeth and East London with their pastoral hinterlands, being the main wool ports: Port Elizabeth also has a large export of citrus fruits and East London of pineapples. The trade of Cape Town is more varied. Cape Town is the main fruit export port in the Union, handling a variety of deciduous fruits from the near hinterland and citrus fruits from the Transvaal. It has a small export of wool and also handles a great variety of agricultural produce from the whole of the Union, maize, butter and eggs mainly from the Transvaal, tobacco, wine, etc., from the south-western Cape.

Of the smaller ports Mossel Bay sends away small quantities of agricultural produce, wool, bitter aloes, etc., and ores of ochre, Port Nolloth exports fish.

Cape Town and Durban are the main bunkering ports in Southern Africa. At the time of Union in 1910, Durban, as the natural outlet of the Natal coalfields, was the more important. With the advent of oil-burning ships, however, Durban lost the advantage to Cape Town which is more conveniently located as a port of call, particularly for passenger and cargo liners, and at the outbreak of war in 1939 was landing and shipping more fuel oil than Durban. Durban, however, still retained a coal bunker trade. The differing functions of these ports as bunkering points was closely related to the nature of their traffic, Cape Town concerned mainly with passengers and cargo liner traffic carried in motor ships and Durban with coal, ores and bulky agricultural products carried in steamers. This is reflected in the nature of the ships calling (Table 29). Since the war, however,

Table 29. Number and Type of Vessels calling at Cape Town and Durban 1919–53

	Cape Town			*Durban*		
	Steamships		*Motor ships*	*Steamships*		*Motor ships*
	Coal-burning	*Oil-burning*	*Oil-burning*	*Coal-burning*	*Oil-burning*	*Oil-burning*
1918–19	2,034			825		
1928–9	1,718		57	1,242		125
1938–9	518	404	562	790	368	376
1948–9	276	822	461	397	733	289
1952–3	75	691	742	89	661	552

there has been a spectacular decline in the number of coal-burning ships calling at Durban with a corresponding increase in the number of oil-burners. In consequence the oil-bunkering trade has expanded so that Durban now vies with Cape Town as an oil-bunkering port, but the coal-bunkering trade has fallen away.

Trade Connections and the Significance of the South African Ports

At present South Africa trades mainly with the United Kingdom but ships of many nations and many lines call at her ports. Durban has connexions with East Africa, Pakistan, and South East Asia; much of the coal exported goes to Pakistan and various African territories; rubber is imported from Malaya. Port Elizabeth has long-standing trade connexions with Australia.

Today the South African ports are assuming a new significance for with the introduction of larger and faster ships and with political unrest in the Middle East they are beginning to regain some of the importance they enjoyed before the opening of the Suez Canal.

During the second world war Cape Town in particular and to a lesser extent Durban became of supreme strategic importance for all ships and convoys passing between Great Britain and Australia, the Middle and Far East. The cargo handled at these ports increased appreciably during the war years and in particular Cape Town became an important bunker and provisioning port. At one stage the *Queen Mary* and the *Queen Elizabeth* lay together in Table Bay.

The closure of the Suez Canal in 1956 again emphasized the great and growing importance of the Cape route. At one stage during the crisis the South African ports were handling twice the normal number of ships. The Suez crisis, however, merely focused the attention of the general public on the problems concerning the transport of Middle East oil to the western nations which had been engaging the Oil Companies for some time. The inadequacy of the canal and the vulnerability of pipelines had already led to the building of fast giant oil tankers too big to use the canal. In addition most shipping companies had already made plans for the building of larger and faster ships. The Suez crisis accelerated a tendency already present. As the shorter Suez route becomes less advantageous or impossible with the advent of the bigger, faster ships, more traffic may be expected to use the Cape ports.

To cater for the increased trade deriving from the expanding South African economy, the new British and Commonwealth Line, formed by the Union Castle–Clan Line merger, is building two new mailships, one of 38,000 tons with a speed of 23 to 25 knots compared with the average of 19 knots of the present mailships, as well as three 18,000 ton tankers, two fully refrigerated cargo boats and three other motor cargo vessels of 10,000 tons. At the same time coastal shipping is increasing now that competitive sea rates on the railways have been abolished, while South Africa is beginning to build up her own mercantile marine.

To provide for the bigger ships and for the increased trade on the international and coastal services the South African Government in 1956 set aside £8 million for harbour improvement, £5 million to be spent on Port Elizabeth and over £2½ million on Durban. In particular Port Elizabeth is to be equipped to handle some of the ore traffic and Durban, where an oil refinery has recently been completed, to handle Middle Eastern oil. At the same time, while further opportunities exist for an extension of facilities at Port Elizabeth in particular, in some quarters it is felt that a new port on the east coast is needed to deal with the coal and mineral ore traffic and perhaps, with Middle East oil as well. Attention has focused mainly on Sordwana Bay which appears to offer the most promising site. Here surveys have been undertaken but so far no proposals have been formulated.

BIBLIOGRAPHY

Most of the information contained in this chapter has been obtained from the Annual Reports of the South African Railways and Harbours Administration for the years 1910 to 1956.

1. See MARGARET MARSHALL. 'The growth and development of Cape Town'. *M.A. Thesis, University of Cape Town*, 1944 (unpublished).
2. C. W. METHVEN. 'The harbours of South Africa'. *Min. Proc. Civ. Eng.*, Vol. CLXVI, 1906.
3. See C. V. METHVEN. 'Durban harbour, South Africa'. *Min. Proc. Inst. Civ. Eng.*, Vol. CXCIII, 1914.
4. See L. C. KING. 'The Durban beach problem'. *S.A. J. Sc.*, Vol. XLVIII, 1952, pp. 314–18.

The Bantu Economy and the Bantu Territories

34

The Bantu Economy and the Bantu Reserves

While the great economic developments described in the preceding chapters have been taking place in the European owned areas, the Bantu reserves, both in the Union and the Protectorates, have stagnated. The increase of the Bantu population has not been matched by any increase in the productivity of their lands. Instead the people have depended more and more on outside sources for support. In a period of rapidly increasing prosperity for South Africa as a whole the Bantu reserves have become areas of increasing and abject poverty. There are many reasons why this has been so. Fundamental are the persistence of the traditional Bantu economy and society, and the growth of the migratory labour system whereby most of the able-bodied males leave the reserves for temporary work on the mines and in industry. In many cases the nature of the land in the reserves has made improvement difficult while attempts at betterment have been thwarted by the innate conservatism of the Bantu and his distrust of the motives of the European. Overall development has been hindered by a lack of money and initiative, technical equipment and skill, by poor transport facilities and totally inadequate education and health services. All these factors together have produced the vicious circle of poor agricultural methods – low productivity – inadequate food supplies – malnutrition and poor health – poor methods of cultivation.

The Extent and Nature of the Bantu Reserves

The extent and nature of the Bantu Reserves (Fig. 180) varies considerably between the Union and the several Protectorates. Briefly the whole of Basutoland and a large part of Bechuanaland are Bantu-owned. In the latter territory the European concessions are very small. Swaziland is about equally divided between the two racial groups while in the Union the Bantu own only 13 per cent of the land.

In Basutoland all the land is held in trust for the Basuto nation and no land has been or may be alienated to Europeans or people of other racial groups.

In Bechuanaland the land was in the sole occupation of the Bantu until the latter part of the nineteenth century when small concessions were made to the British South Africa Company in the Tuli, Gaberones, and Lobatsi districts and to the Tati Company farther north. With the exception of a small portion of the Tati concession, rented by the Government in perpetuity from the Tati Company and set aside as a small Native reserve, all these areas are open to European settlement and for the most part are occupied and farmed by Europeans. Large tracts covering 103,250 square miles and known as the Bamangwato, Batawana, Bakgatla, Bangwaketse, and Bamalete Reserves have been set aside for the Bechuana tribes. The rest of the territory, totalling about 165,000 square miles, i.e. more than half – is in Crown land. Parts of it are occupied by Natives, e.g. in the Chobe and Kalahari areas, and parts by Europeans, e.g. the Ghanzi area where a few farms have been sold outright and others leased to European farmers. No general policy has been declared with regard to the unoccupied Crown land but the present tendency is to use suitable areas for the settlement of Natives from the over-populated small reserves in the east of the country.

By contrast to the position in Bechuanaland the whole of Swaziland had been given out in land concessions to Europeans during the nineteenth century. Although a large part of it was used as winter grazing by Transvaal sheep farmers, little of it had been occupied by the Europeans and, following a petition from the Swazi people, one-third – 1·6 million acres – was expropriated and given to the Swazi nation in the partition of 1909. A similar acreage was allocated to the Europeans and the remainder proclaimed Crown land. In 1942 a further 135,000 acres of the 157,000 acres then held by the Crown were set aside for Native settlement and an additional 230,000 acres were purchased from Europeans with funds provided under the Colonial Development and Welfare Act of 1940. Thus today the Swazis own 48 per cent of the area of the territory but make up 98 per cent of the population.

In the Union the division of land between European and Bantu was fixed by the 1913 Natives Land Act while provision was made for acquisition of additional areas for Bantu occupation by the Native Trust and Land Act of 1936 (see ch. 6, p. 113). The extent of the Scheduled Native Reserves as prescribed by the 1913 Act was 10·7 million morgen or 22·7 million acres. The area of land owned by or reserved for ownership by the Bantu on the eve of the passing of the 1936 Act was 12·3 million morgen or 26·1 million acres. Between 1936 and 1955 nearly 6·8 million morgen or 14·6 million acres were purchased by the South African Native Trust so that the area at present in Native ownership is 17·5 million morgen[1] or 37 million acres, about 13 per cent of the total area of the Union.

In South West Africa Bantu reserves cover approximately 51 million acres.

The present Bantu territories are more or less coincident with areas which either did not attract the European settlers or which the Bantu succeeded in keeping from them. Generally speaking they comprise poorer lands than those held by the Europeans. Thus the greater part of Bechuanaland and South West

Africa is semi-desert or desert country; Basutoland is mountainous. The best lands occur in the Union and Swaziland where, however, there are considerable variations of climate and land quality between one reserve and another.

In the Union most of the reserves lie within the warmer and better watered part of the country. Indeed 76 per cent of the Bantu lands receive more than 20 inches of rainfall a year and this includes one-half of the area of the Union

Fig. 180. The distribution of the Native Reserves and Native Purchase Areas.

characterized by a temperate rainy climate (Cf. in the Koppen climatic classification), generally regarded as the most productive climatic type in the world. The reserves of the western Transvaal and northern Cape, however, are semi-arid and those lying within the Ladysmith basin of Natal and the Bushveld basin of the Transvaal receive too little rainfall for subsistence agriculture and their thornveld vegetation, while excellent for stock, has a low carrying capacity. The better-watered reserves, moreover, for the most part comprise agriculturally difficult terrain. The Transkei excepted, the best lands are in European ownership. Thus in Sekukuniland the fertile irrigable river valleys belong to European farmers and the Bapedi have only the dry mountainous country (see Plates 134–8). In the

eastern coastal belt nearly all the level or undulating lands are in European farms and the Bantu lands are at best hilly or broken and at worst mountainous (Fig. 181). The Bantu reserves contain the most readily eroded lands in the country and with overpopulation, poor methods of agriculture and overgrazing it is small wonder that they have become bared by sheet wash and scored by gullies. Yet given wise management they are potentially productive.

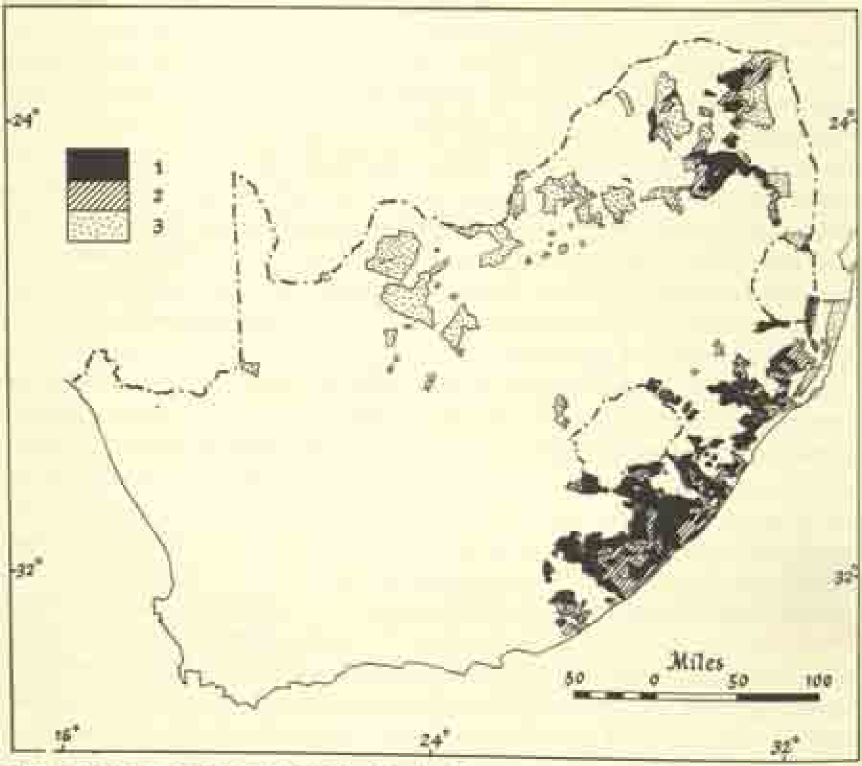


Fig. 181. The relative relief of the Native Reserves of the Union of South Africa.
(Adapted from the map in the *Summary of the Report of the Commission for the Socio-Economic Development of the Bantu Areas within the Union of South Africa*, UG 61, Pretoria, 1955.)
1. Mountainous or very broken; difference in height between highest and lowest point within a square of 5 Degree Minutes (±5 miles square) 1,000 feet and over. 2. Hilly or broken; difference 500–1,000 feet. 3. Flat or softly undulating; less than 500 feet.

In Swaziland the 1909 partition gave the Swazis a fair share of good quality land for, receiving in all 38 per cent of the territory, they were granted 44 per cent of the good quality land, 34 per cent of that of medium quality and only 29 per cent of the poor land.[2] Moreover, much of the land in the lower categories, although unsuitable for the traditional Bantu agriculture, is actually potentially

productive under scientific management. For example with irrigation the Low-veld is suitable for a great variety of tropical fruits and annual crops; and with the provision of water and exercise of disease control measures, for large-scale cattle ranching.

Bantu Land Tenure and the Bantu Economy

Traditionally according to Bantu custom the land occupied by a tribe belonged to the tribe as a whole. Trusteeship was vested in the Paramount Chief. Each tribesman received from the Chief or deputy Chief a homestead allotment for residential purposes, and an arable allotment for cultivation, polygamists obtaining separate allotments for each wife. The remainder of the tribal holding was used as common pasturage from which, as membership of the tribe increased and new households were formed, further residential and arable allotments were made (see Plate 81). Except in the Ciskei, notably Glen Grey where individual land tenure based on the principle of one man, one lot, was introduced during the latter part of the nineteenth century, this type of land tenure persists in most of the Scheduled Native Reserves of the Union and in the Protectorates today. The only modification is that in the Union ownership is now vested through the South African Native Trust in the State.

Under the communal system of land tenure the arable lots were used for the cultivation of maize and Kaffir corn, pumpkins and beans; cattle and other domestic stock were kept on the commonage, wild fruits and spinach were collected from the veld and wild game hunted. The men looked after the cattle; all the cultivation was done by the women with the aid of the hoe (see Plate 79). The economy turned on the keeping of cattle which were the most important form of real wealth providing milk, meat, and hides. *Amasi* or curdled milk provided the proteins and fat-soluble vitamins in the otherwise starchy diet of mealie-meal or maize porridge. Kaffir beer, brewed from Kaffir corn, constituted an essential form of nourishment, providing necessary vitamins. The importance of cattle led to their becoming the centre of Bantu custom and ritual, especially that of *Lobola* whereby cattle were handed over by the family of the bridegroom to the family of the bride as a necessary preliminary to marriage.

The cultivated fields were never fenced and after the crops had been harvested the cattle were allowed in to eat up the maize stalks, the arable lands being regarded as part of the commonage until the next sowing. This practice led to the compacting of the earth on the maize fields during winter, making their tillage difficult in the ensuing spring and encouraging sheet erosion after the first summer rains. Manuring was never practised, the dung collecting in the cattle kraals being used as fuel and for making the hut floors. In the absence of a system of crop rotation or of fallow and without the use of manure the soils soon deteriorated. In ancient times the old worked-out lands were then abandoned and new ones taken on virgin veld. When the lands in any area became exhausted the tribe moved on, a practice which frequently involved attacking and

dispossessing weaker neighbours. This practice became impossible with the establishment of European rule and the delimiting of the areas available to the Bantu peoples.

In essence the agricultural economy of the Bantu reserves today differs little from the traditional one but its balance has been upset by the increase in the population relative to the amount of land available and by the fact that it is no longer possible to move and take new land from weaker neighbours. With the increase in the population and number of households the area available for grazing has diminished while at the same time the number of cattle has increased. Overgrazing, the deterioration of pasture and severe erosion of the land (Plates 80 and 138) have inevitably followed. With less and poorer grazing the cattle have deteriorated in quality for only the toughest and most resistant animals are able to survive under the prevailing conditions. Today the type of scrub cattle common in Swaziland, Basutoland, and the Union reserves, partly because of its poor quality and partly because it is half-starved, gives very little milk. In Polela, in the Umkomaas valley which may be taken as fairly representative, at least of the densely populated Union reserves, milk yields of only 1½ to 2 pints per day in June and 4½ pints per day in December are obtained.[3] The lactation period is very short and most cows are dry from June to September. In consequence milk which in a fermented form, was once a staple article of diet has become a rarity. Further the scrawny underfed cattle have very little value for slaughter. Yet while their economic value has declined the importance attached to cattle for social reasons has increased. The main reason for this is that cattle form the one obvious form of real investment. Men returning from the mines and factories cannot invest their savings in the purchase of land; an arable allotment is given only for a wife. Cattle, however, can be grazed on the commonage and there is no restriction on the number anyone may acquire. Facilities are available for investment in Savings Banks but these are new and improperly understood by the Bantu who in any case prefer to purchase cattle which constitute real wealth and may be used for *Lobola* when they wish to take a wife. Because of the value attached to numbers of cattle regardless of quality, the cattle population in the Union reserves increased from 1·6 million head in 1918 to 3·8 million head in 1930[4] after which the numbers remained practically stationary until 1939 and then fell to 3·3 million in 1950, which bearing in mind the increase in the area of the reserves since 1937, is clear evidence of their declining carrying capacity. The indications are more striking when note is taken of the decrease in the number of sheep from 4·7 million in 1930 to 3·3 million in 1950. Goats, however, which are able to survive on poorer grazing and are notorious as destroyers of vegetation, increased from 3·2 to 3·9 million in the same period. In Basutoland, although fluctuating with the seasons, stock numbers have changed little since 1935.[5] In Bechuanaland on the other hand the cattle population has increased from less than ½ million head in 1920 to over 1 million head in 1950. In Swaziland it has likewise doubled and now numbers over 400,000 head.

Apart from the introduction of the plough, which has made cultivation easier and given the male Bantu a role in crop production, there has been little change in the methods of tillage or in the crops grown. Apart from ploughing, all cultivation is still done by women using hand hoes. Planters, harrows, cultivators, and other large items of equipment are very rare. Seed selection is seldom practised and although sowing in rows is becoming more common, much seed is still sown broadcast. In the Union reserves artificial fertilizers available at subsidized prices are used by the more enlightened Natives, but manure or compost are rarely used. In most areas maize is the leading crop, normally occupying 90 per cent of the arable acreage. In the drier north-western districts, however, its place is taken by Kaffir corn and millets. Elsewhere only sufficient Kaffir corn is grown to supply the household with Kaffir beer, although it is a safer crop than maize under dry conditions and on poor soils and has a higher food value. Pumpkins and beans are grown in the maize field, and potatoes and tobacco occupy small patches. Groundnuts are grown in parts of Natal and the Transvaal. Except on irrigation schemes fruits and vegetables are rarely grown. Crop rotation is not practised and the same field is cultivated until it is exhausted when it is left fallow and new land cleared. Crop yields are very low. In the Union and in Basutoland only 1½ bags of maize per acre are normally obtained whereas the Bantu on European farms obtain double this yield and the Europeans treble. In the 1949–50 season a total of 8·6 million morgen (16 million acres) were planted to crops in the Union. Nearly one-quarter of this acreage was in the Bantu reserves which, however, produced only 10 per cent of the total crops. Moreover, whereas the Bantu farmers produced nearly one-quarter of the Union maize crop in 1918–24 period, during 1936–52 period their contribution was only 10 per cent. While the yields have been increasing on the European farms, on the Bantu lands they have at best remained the same and in many areas decreased in consequence of declining soil fertility.

Income and Standard of Living in the Reserves

The family income obtained from the traditional Bantu peasant agriculture is very low, although not as low as in comparable areas in Latin America.* It varies considerably with the nature of the land and with the density of the population living on it. The position in the Union Reserves is given in Table 30. Detailed figures are not available for the Protectorates, but the information available indicates that incomes are similar to those in comparable Union reserves. In the Bechuanaland reserves the people are in some ways better off than people in comparable areas of the Union; for example the number of stock per head of population, at 17, is higher, but, on the other hand, in consequence of the low and unreliable rainfall, crop failures are usual and yields extremely low. In the Union the highest and most regular incomes are obtained by Bantu farming under

* In Minas Gerais, Rio State, and the states of north-eastern Brazil, for example, incomes of £12 per year and less are common on small subsistence farms.

European supervision on Government irrigation schemes. The lowest prevail in the climatically most favourable areas where over-population is critical.

Table 30. The Average Bantu Farm in the Union of South Africa[1]

Union Reserves	*Average Area Cultivated Acres*	*Average number of Stock*	*Farm Income from Crops %*	*Farm Income from Stock %*	*Average Income per Family £*	*Average Farm Income per Family £*
High rainfall mixed farming areas	4·6	10	47	53	52·5	29·85
Low rainfall mixed farming areas	7·4	6	26	74	27·7	9·2
Pastoral farming areas	8·9	16	15	85	49·2	39·95
Irrigation schemes under European supervision	3·2	5	87	13	115·5	110·7
Irrigation schemes under Bantu control	3·6	5	82	18	39·35	28·8

As a result of their contacts with the European the Bantu have acquired new tastes and a desire to maintain a standard of living above that of bare subsistence. In all the reserves the income obtainable from farming is insufficient for the purchase of additional food, clothing and household equipment which the people have come to regard as necessities. It is very largely in order to bridge the gap between expenditure and income and only partly to earn money for the payment of tax, that the Bantu leave the reserves temporarily to work for the Europeans.

The Influence of the Migratory Labour System

The migratory labour system originated with the opening of the Witwatersrand goldfield when the enormous demands for unskilled labour could be met only by engaging Natives from all the territories of Southern Africa on a short-term contract basis. It has expanded with the growth of manufacturing industry. To-day its persistence is due, partly to the continued and increasing employment of Africans from territories outside the Union in the mines, partly to the desire of the Bantu to retain a foothold in the reserves and partly to the inadequate housing for Bantu families in the European towns. Its implications are as serious for the economy and well-being of the reserves as they are for industry and the industrial towns.

Perhaps the outstanding feature of the migratory labour system has been its ready acceptance by the Bantu. This is directly associated with the traditional role of the male Bantu as warrior, hunter and herdsman and that of the Bantu woman as tiller of the soil. With the coming of the European the Bantu men lost their function as warriors and hunters, but were unwilling to undertake the 'women's work' of cultivating the soil. No longer able to prove themselves in battle they were ready to 'achieve their manhood' and enjoy an adventurous life by working in the mines.

Today the absence of the male Bantu from the reserves is a severe handicap to agricultural improvement there. Some idea of the scale of the absenteeism may be gauged from the fact that at the 1946 Census in Keiskammahoek there were in the 25 to 29 years age group only 36 men to every 100 women.[8] Since 1939 increasing numbers of women in the same age group have also become temporary workers in the towns, often leaving their children in the reserves in the care of old relatives. Of the total population of Keiskammahoek more than half of the men were away working in the towns and nearly 40 per cent of the women. This is representative of the position in most of the Union reserves; the position in the Protectorates is similar. In 1946 at least 200,000 Natives from Basutoland (total population 561,000) 39,000 from Bechuanaland (population 296,000) and 34,000 from Swaziland (population 181,000) were working in the Union. Although many migratory workers try to return home to plough their lands and although there is a good deal of mutual aid at this season, most of the other cultural operations devolve upon the women and increasingly upon the old and less able-bodied section of the population. Thus those responsible for the cultivation of the land are physically incapable of adopting improved methods, while the prolonged absences of the male Bantu from the land engenders and perpetuates a lack of concern for its productivity. Furthermore the constant comings and goings of the population make the teaching of improved methods virtually impossible.

Betterment in the Bantu Reserves and the Future

Although the destructive agricultural practices of the Bantu and the extent of overgrazing and soil erosion had been recognized both in the Union and the Protectorates little was done to remedy the position before 1935. For this the general lack of technical knowledge of soil conservation work and the general shortage of money in a world shaken by the Great Depression, were largely responsible. In 1935, however, Great Britain made a loan for soil conservation projects in Basutoland and a year later the Union provided that all lands 'released' for native occupation should automatically become betterment areas in which the agricultural operations of the settlers are supervised. The second world war delayed progress but since 1946 large sums of money have been voted for the improvement of the Bantu territories. In the Union £90,000 was made available in 1945; by 1953 the amount had increased to over £1·3 million. In 1946 Great

Britain allocated £830,000 to each of Basutoland, Swaziland, and Bechuanaland for development over a ten year period, one-third of the money to be used for agricultural improvement.

Only on Trust farms in the Union and on new settlement schemes in the Protectorates is any direct control exercised over the Bantu people. Elsewhere betterment measures can be effected only when desired by the people. In all areas the aims have been twofold – to stabilize the soil and to improve crop and animal husbandry practices and thereby increase production. To achieve the former, lands have been contoured and check dams built; to achieve the latter, good seed and artificial fertilizers have been made available at subsidized prices, schemes for the subsidized purchase of equipment introduced; efforts have been made to improve the quality of stock by the establishment of breeding stations, sale and loan of breeding animals and introduction of milk-production projects; and in order to reduce cattle numbers, organized cattle auctions have been held. At the same time the Bantu have been trained for extension work, demonstrations have been arranged and instruction in better husbandry given. But while considerable progress has been made with stabilization measures, except on the Trust farms in the Union, where some control can be exercised, there has been little improvement in crop and animal husbandry practices[7] and attempts to improve the quality of stock and reduce their numbers have been unpopular. The reasons for this are obvious. It is not possible to introduce crop rotation and ley farming, essential to the maintenance and building up of soil fertility 'where the arable land is insufficient to produce the food requirements of the population, nor is efficient stock farming possible under conditions of gross overstocking'. Moreover, in all areas the Bantu themselves are less concerned about soil fertility and stock carrying capacity than about their stake in the land.

The crux of the problem is that the reserves cannot support in agriculture all the Bantu people. Even if considerably enlarged they still could not do so. It is inevitable that, as in all developed countries, some people will have to forsake their stake in the land and work in mines, industry or commerce. The question is whether in the reserves or in the European centres of the Union. The opportunities for industrial development are extremely limited in the Protectorates. They are greater in the reserves of the Eastern Marginal Belt of the Union. Here industrial development in and at the borders of the reserves has been advocated in the Tomlinson Report of 1955. It must be emphasized, however, that there can be no solution to the problems unless those taking work in non-agricultural pursuits give up their claim to the land in order that there may be sufficient land for an African peasantry; and this will be unpalatable to the Bantu.

BIBLIOGRAPHY

1. Summary of the Report of the Commission for the Social-Economic Development of the Bantu Areas within the Union of South Africa (The Tomlinson Report). U.G. 61/1955.
2. PETER SCOTT. 'Land policy and the native population of Swaziland'. *G.J.*, Vol. CXVII, Pt 4, 1951.
3. Social and Economic Planning Council. Report No. 9. 'The Native Reserves and their Place in the economy of the Union of South Africa'. U.G. 32/1946.
4. ELLEN HELLMAN and LEAH ABRAHAMS. Editors. *Handbook on Race Relations in South Africa.* Oxford University Press. 1949.
5. See HUGH ASHTON. *The Basuto*. Oxford University Press. 1952.
6. D. HOBART HAUGHTON and EDITH M. WALTON. *Keiskammahoek Rural Survey*. Shuter and Shuter. 1952.
7. T. J. D. FAIR. 'The Drakensberg native locations'. *S.A.G.J.*, Vol. XXVII, 1945, pp. 65–72.
8. Colonial Office Reports.

The Major Regions

73. Passenger train in the Natal Midlands where steep gradients necessitating numerous acute curves led to the early electrification of the main Durban–Johannesburg railway line. Note, however, that sections of this line, as in this photograph, are still single track. In the background wattle plantations occupying the lower slopes with an easterly aspect.

74. Passenger train on the Cape Town–Kimberley and Johannesburg main line railway approaching the Great Karoo after crossing the Cape mountains. The photograph was taken from the back of the train. Since it was taken (in 1947) the line has been electrified as far as Touws River, thereby eliminating the necessity for banking engines over the steep gradients and difficult curves between De Doorns and Touws River.

75. Cape Town and the Cape peninsula. View southwards showing from left to right, the Devil's Peak, Table Mountain and the Lion's Head with the residential suburbs of the city of Cape Town climbing their lower slopes. Dominating the foreground is the Duncan Rock with on its right the older Alfred and Victoria basins. Since the photograph was taken in 1953 the large area of reclaimed land behind the Duncan Rock has been developed.

76. The Bay of Natal and the port of Durban. Within the bay the mud-banks and the shipping channels are clearly visible. On the northern side (right), the 'T' jetty and the Point docks; in the background the reclaimed land of Congella with behind the residential areas extending over the Berea; in the foreground the Bluff with coaling berths on its inner margin. North of the 'T' jetty the commercial centre with its axis running down to the Marine Parade and Back Beach may be distinguished.

77. Algoa Bay, Port Elizabeth. On the right, bridged by road and railway, is the Baakens river. The newest quay, the Charl Malan, with its pre-cooling sheds is on the north (left) side of the harbour. In the foreground the high ground, built of Table Mountain Sandstone, carries European residential areas with an open space preserved around the lighthouse. Below is the commercial centre flanked by industrial areas near the docks.

78. Buffalo River Harbour, East London. Note the dredger at work to keep the channel open.

79. Zulu women, with their hair dressed in the traditional Zulu fashion, carrying their hoes through their maize lands in Natal. In the Bantu areas all the cultivation is done by the women. The maize is at the tasselling stage.

80. The typical beehive hut of a Zulu kraal. The cultivated lands are seen in the middle distance gashed by great gullies torn by erosion.

81. Typical landscape in the Transkei. Innumerable native huts dot the surface. Before them are the arable lands enclosed by a 'hedge' of aloes. The rest of the land is in communal grazing which, as in the foreground, is usually over-grazed and eroded.

82. Xhosa herdboys, a Transkeian scene near Umtata. With the men-folk away working on the mines and in industry, the children look after the cattle. Some attempt has been made to cultivate contourwise the arable lands on the lower slopes in the middle distance.

83. Xhosa women in front of a typical Xhosa hut in the Transkei.

84. Pondo boy and girl in the hilly belt of country near the Mlengana Pass in the Transkei; between Umtata and Port St Johns.

85. The Cedarbergen. Table Mountain Sandstone builds the Middleberg (peak 4,979 feet) on the east (right) and the Suurvleiberg (peak 5,313 feet) on the west (left). Between is the Algeria valley tributary to the Olifants river.

86. The Cedarbergen, looking northwards towards the Uitkyk Pass from the Driehoek (Matjies river) and showing the Sneeuberge on the west (left) and the Middelberg on the east. In the foreground typical Karoo shrubs.

87. The Cedarbergen with the Tafelberg peak (6,465 feet) from the Sneeuberge. The Matjies river valley (not visible in the photograph) lies between the two ranges. Table-topped mountains are characteristic of the Table Mountain Sandstone, so also is the rough barren ground in the foreground. The vegetation is characterized by tussocky grasses and renosterbos.

88. The Elgin Basin showing orchards on the gentler slopes and a clover ley providing grazing for dairy cattle on the steep slopes. There is a growing tendency to combine dairying, to provide fluid milk for the Cape Town market, with fruit production in this region. The windbreaks of Blue Gums, *Eucalyptus diversicolor* (on the right), and of *Pinus insignis* (on the left) are characteristic features of the landscape.

89. Young eucalyptus trees planted on the slopes of the Kogelberg near Steenbras dam. The sclerophyllous bush dominated by *Protea* spp. (seen in the background and in the right foreground) is killed out when the forest canopy closes.

90. Timber plantations on the western slopes of the Kogelberg. The plantations on the lower ground in the middle distance are of eucalyptus trees, those on the upper slopes in the background of conifers.

91. View from the Paarl Berg (in the foreground) across the Great Berg valley to the Klein Drakenstein mountains (left), the Wemmershoek mountains (behind) and the Groot Drakenstein mountains (right). Vineyards occupy the lower slopes of the Paarl Berg and the valley lands of the Great Berg river. Forestry plantations occur on the lower slopes of the Drakenstein mountains.

92. The wheatlands of the Swartland near Darling. On the hillside contour cropping, clearly seen in the photograph, is now practised but erosion gullies, a legacy of the days when high wheat prices encouraged the ploughing of steep slopes for wheat monoculture, are still evident.

93. Wheat lands of the Ruens (fashioned in Bokkeveld Shale) with the Babylonstoren range (built of Table Mountain Sandstone) rising in the background. The 'ridge' tops only are used for wheat while the shallow kloofs remain in natural veld which provides some grazing for sheep.

35

Introduction: The Major Regions

In attempting a regional division of Southern Africa it is essential, as in any other country, to recognize the outstanding features of both the physical and cultural landscape of any particular area and to assess the relative importance of physical, economic, and social factors in producing its regional unity. Many criteria must necessarily be considered but some are of much greater significance than others.

Climate is of fundamental importance, exerting a profound influence over earth sculpture, soil formation, vegetation, and agricultural activities. Rainfall is a critical factor and its distribution suggests a division of the country into three broad belts: an eastern one in which the rainfall is adequate and, being concentrated in summer, permits the production of a wide range of crops as well as the establishment of good pastures; a south-western area where sufficient rainfall is received in winter for cool season crops; and the arid interior where the total fall is too small for crop production. Within each of these belts the relief or surface form frequently determines the suitability or otherwise of the land for arable cultivation and in many cases sets the scale of the operations; the features of the relief and drainage determine the opportunities for irrigation. The quality of the soil often governs the choice of crop and the nature of the vegetation and its value for grazing purposes largely dictate the form of livestock enterprise.

Within the limits imposed by the physical environment, economic considerations such as agricultural prices, labour supply, markets, transport facilities, etc., and social factors such as the size of the farm unit, the financial and technical know-how of the farmers, etc., largely determine the agricultural economy and the specific land use. Together these produce the agricultural landscape. And superimposed on this is the urban and industrial landscape resulting from mining and manufacturing activities.

The division adopted here is based very largely on this sequence. Essentially it is the result of the superimposition of the agro-economic map of the Union Department of Economics and Markets (Fig. 182) over the Physiographic Regions map of J. H. Wellington (Fig. 12) over the climatic regions map of S. P. Jackson (see Fig. 37) modified by the separation as distinct regions of the

mining and manufacturing conurbations. In many cases the physical and cultural boundaries approximately coincide; where there is divergence the essential character of the region has been considered of first importance and according to

Fig. 182. The agro-economic regions of the Union of South Africa.

(After the Division of Economics and Markets of the Union Department of Agriculture.) 1. *Crop area of the winter rainfall belt:* 1a. Swartland and Sandveld; 1b. Caledon-Bredasdorp area. 2. *Deciduous fruit growing area of the South-Western Cape.* 3. *Diversified farming area of the Southern Cape.* 4. *Little Karoo irrigation farming area.* 5. *Eastern coastal area:* 5a. East London fruit growing and dairying region; 5b. Transkei coastal zone of Bantu agriculture; 5c. Sugar cane belt; 5d. Eastern Lebombo area. 6. *Eastern Thornveld cattle grazing area.* 7. *Diversified farming areas of the Eastern Plateau Slopes.* 8. *Grazing areas of the eastern mountains.* 9. *Areas in which irrigation is important:* 9a. The eastern Transvaal Lowveld; 9b. The eastern Bankeveld; 9c. The Sour Highveld; 9d. The Hardveld; 9e. The southern Bankeveld and Bushveld. 10. *The inland plateau with adequate rainfall for dryland crop production.* 11. *Other diversified farming areas:* 11a. The Pietersburg Plateau; 11b. The Springbok Flats; 11c. Western Highveld; 11d. Queenstown plain; 11e. The South-Eastern Cape. 12. *Cattle grazing areas of the Transvaal Lowveld and the Kalahari Thornveld.* 13. *The Great Karoo semi-arid stock rearing area.* 14. *The North-Western Cape arid stock rearing area.* 15. *Areas of intensive irrigation farming:* 15a. The Olifants river valley, Clanwilliam; 15b. The Sundays river valley below Van Ryneveld's Pass dam; 15c. The Sundays river valley below Lake Mentz; 15d. The Great Fish river valley; 15e. The Kat river valley; 15f. The Vaal-Hartz irrigation scheme; 15g. The middle Orange river valley below Buchuberg dam.

the stage of development the boundary is in some cases physical and in others economic or social.

Space does not permit a consideration of all the regions. Those selected for study in the following chapters have been chosen either because they are economically important or because they portray certain characteristic features

and/or problems – physical, economic and social – of South African life. An attempt has in fact been made to study the various facets of South African life in their regional setting. Thus the South-western Cape is studied as the area of early

Fig. 185. Major geographical regions.

1. *The South-Western Cape:* 1a. The Western Lowland; 1b. The Southern Lowland; 1c. The Mountains, Valleys and Basins, of the Cape Ranges. 2. *The Southern Cape:* 2a. The Mountains and Valleys of the Cape Ranges; 2b. The Little Karoo. 3. *The South-Eastern Cape.* 4. *The Eastern Plateau Slopes:* 4a. The Uplands of the Transkei, Natal and Western Swaziland; 4b. The Eastern Coastal Belt; 4c. The Lowveld of the Eastern Transvaal and Eastern Swaziland. 5. *The Highveld Plateau:* 5a. The Highveld; 5b. The Kaap Plateau; 5c. The Upper Karoo. 6. *The Witwatersrand.* 7. *Basutoland.* 8. *The Transvaal Plateau Basin:* 8a. The Bankeveld; 8b. The Bushveld Basin; 8c. The Northern Plateaux; 9. *The Limpopo Depression.* 10. *The Semi-Desert Area of the Cape Middleveld.* 11. *The Highlands of South West Africa.* 12. *The Kalahari Basin.* 13. *The Desert Country of the Namib:* 13a. The Hot Desert of the Interior; 13b. The Cool Coastal Desert.

European settlement and long-established agriculture; Basutoland as the domain of the Bantu least touched by European influences; the South-eastern Cape is viewed as the meeting ground of European and Bantu, characteristically transitional in its physical, economic, and social environment; the Eastern Plateau

Slopes are seen as a region of great diversity, originally Bantu held and now characterized by the juxtaposition of prosperous European owned sugar cane and wattle plantations, fruit and cattle farms on the one hand and poverty stricken Bantu Reserves characterized by the traditional Bantu economy on the other; the Highveld Plateau is studied as the home of the most important agricultural and industrial regions of South Africa, the Transvaal Plateau Basin as a pioneer region within which the physical environment exerts a profound influence over economic activities. And the Witwatersrand is studied as the great mining and industrial region and the scene of the most controversial economic, social, and racial problems.

36

The South-western Cape

The south-western Cape is distinguished from the rest of Southern Africa by its so-called Mediterranean climate. It is, however, a region of great diversity with regard to both its physical environment and economic activities.

The outstanding geomorphological features are those associated with the Cape ranges. These are the product of erosion acting on the two series of fold mountains which, thrown up by the Permo-Triassic earth movements,[1] parallel the coasts and meet in a great knot between Ceres and Elgin. These mountains were originally built of Table Mountain Sandstone (quartzite), Bokkeveld shales and Witteberg quartzites but denudation has removed the upper formations so that today little of the Witteberg quartzites remain, the Bokkeveld shales are preserved only in the synclines and the Table Mountain Sandstone is exposed in the cores of the anticlines. The present ranges are generally anticlinal while the main valleys follow the synclines. Thus the Cedarberge (Plates 85 and 86), the Hottentot Hollands, the Langeberge, and Sonde Einde Berge are all anticlinal while the Olifants, Great Berg, and Breede rivers occupy downfolds, the last-mentioned one accentuated by faulting in Tertiary times which has preserved Cretaceous rocks (Fig. 184). The Tulbagh basin, however, occupies a breached anticline in which erosion has bared the soft Malmesbury slates underlying the Cape rocks. Generally speaking the main ranges and valleys are parallel to one another and remarkably continuous, due no doubt to the simple nature of the original folding, but over the meeting place of the two sets of folds a complexity of mountain masses and enclosed structural basins has developed (Fig. 185). Here the maximum elevations are attained – 6,552 feet in the Drakenstein mass, 7,386 feet (Matroosberg) in the Hex river mountains, and 6,808 feet in the Kwadouwsberg. The largest structural basins are those of Ceres (area 140 square miles, average elevation 1,000–2,000 feet) and Elgin (area 140 square miles, average elevation 500–1,000 feet). Due to differential erosion between the tough Table Mountain quartzites and soft Bokkeveld shales, the mountains everywhere rise abruptly from the valleys and basins thereby producing magnificent scenery but formidable barriers to communications.

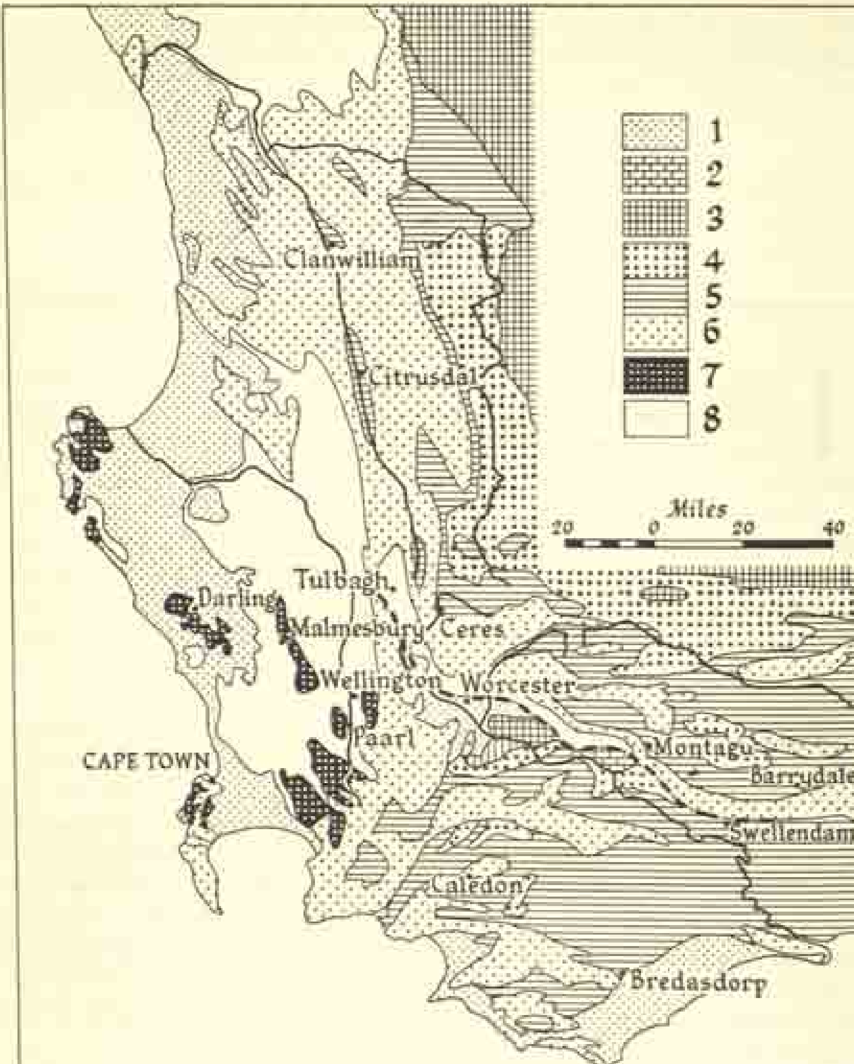


Fig. 184. The South-Western Cape; geology.

1. Superficial deposits of Tertiary to Recent age. 2. Enon beds of Cretaceous age. 3. Karoo beds. 4. Witteberg Sandstone of the Cape System. 5. Bokkeveld Shale of the Cape System. 6. Table Mountain Sandstone of the Cape System. 7. Granite. 8. Rocks of Pre-Cape Systems; mainly Malmesbury beds but with rocks of the Loskop System outcropping north of the Great Berg river and in the Breede river valley. The heavy dotted line marks the line of the Worcester fault.

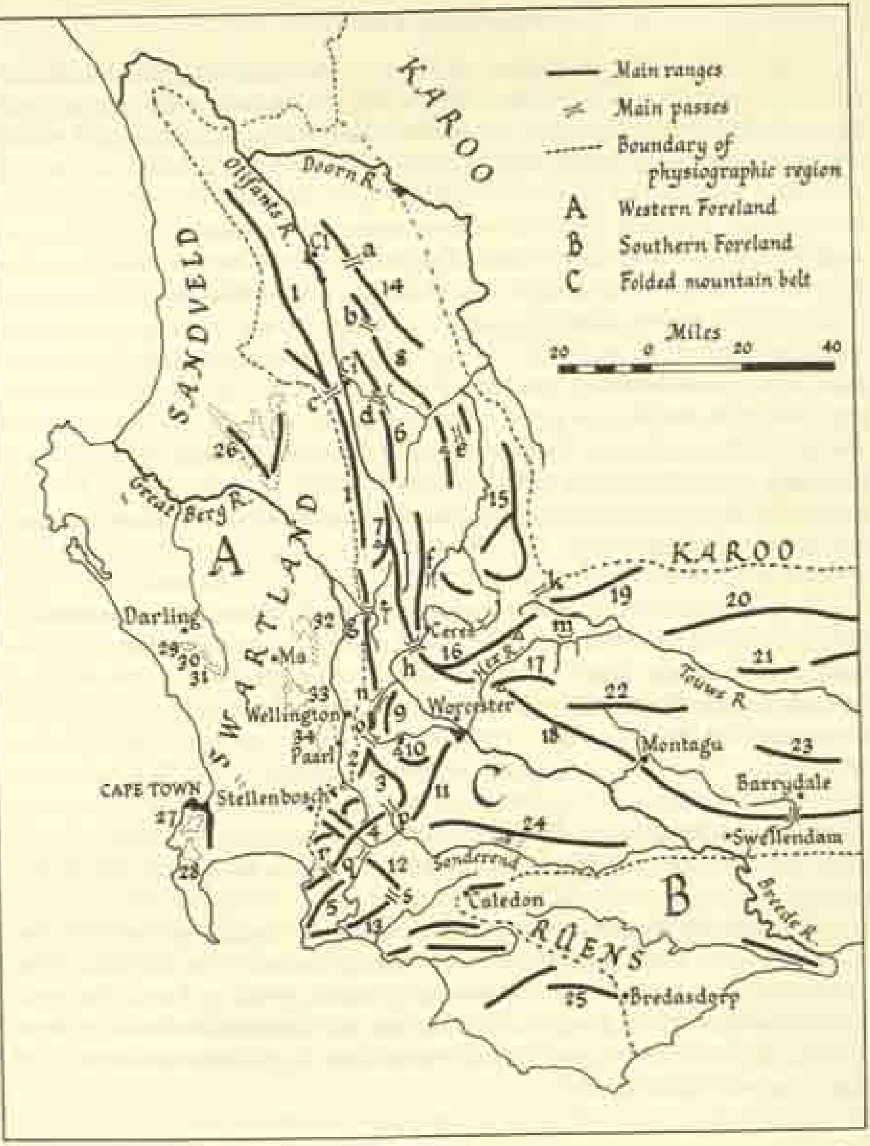


Fig. 185. The South-Western Cape; physiographic regions and main orographic features.

Main folded mountain ranges: 1. Olifants river mountains; 2. Drakenstein; 3. Wemmershoekberge; 4. Hottentot's Holland mountains; 5. Kogelberg; 6. Cold Bokkeveld mountains; 7. Great Winterhoek mountains (Great Winterhoek peak 6,815 feet); 8. Skurweberg range (Sneeuwkop peak 6,800 feet); 9. Slanghoekberge; 10. Du Toits Berge (Du Toits Kloof peak 6,552 feet); 11. Stettynberge; 12. Groenlandberge; 13. Paardeberge; 14. Cedarbergen; 15. Swartruggens; 16. Hex River mountains (Matroosberg peak 7,386 feet); 17. Kwadouwsberge (Keeromsberg peak 6,808 feet); 18. Langeberge; 19. Bonteberg; 20. Witteberge; 21. Anysberg; 22. Wagenboomsberge; 23. Warmwatersberg; 24. Riviersonderendberge; 25. Bredasdorp mountains; 26. Piketberg; 27. Table Mountain and Twelve Apostles; 28. Constantia mountains. *Granitic mountain masses:* 29. Kapokberg; 30. Contreberg; 31. Dassenberg; 32. Kasteelberg; 33. Paardeberg; 34. Paarlberg. *Main mountain passes:* a. Pakhuis; b. Uitkyk; c. Grey's; d. Buffelshoek; e. Blinkberg; f. Gydo; g. Roodezande (Tulbagh Kloof); h. Mitchell's; j. Theronsberg; k. Karoo Poort; m. Hex River; n. Bains Kloof; o. Du Toit's Kloof; p. Franschhoek; q. Viljoens; r. Sir Lowry; s. Houwhoek.

The Cape ranges are flanked on their seaward side by the western and southern lowlands, which, while developed on ancient rocks – the Malmesbury slates of the Primitive Systems – are newer features, only emerging from beneath the sea in geologically recent times. The Cape rocks were originally laid down on an eroded basement of contorted Malmesbury rocks and subsequently folded. Later erosion gradually reduced the mountains until eventually in the west the stage was reached when only islands of resistant Table Mountain Sandstone and of granite stood above the shallow seas which covered the Malmesbury basement. In the south not even islands remained. In these shallow seas calcareous sands were deposited. Then gradually the present lowlands emerged from beneath the seas, being simultaneously attacked by erosive agents. The mountain streams extended their courses and began to remove the new deposits and to cut into the marine bevelled surface of Malmesbury rocks, thereby producing the undulating landscape of the Swartland and the Rûens (Plates 92 and 93), the former, however, diversified by the rounded granite 'islands' of the Paardeberg (2,492 feet) and Paarl Rock (2,396 feet) (see Plates 91 and 94), and the steep-sided Table Mountain Sandstone 'islands' of the Piketberg (4,780 feet), Kasteelberg (3,100, feet), and Table Mountain (3,567 feet) itself. Nearer the present coast, however, the old rocks remain covered with calcareous sands overlain by blown sand. In these areas, known as the Sandveld and Cape Flats in the Western Lowland and the Duineveld in the Southern Lowland, there has been little time or opportunity for dissection, the rivers meander over the surface in wide shallow valleys while locally, as along the coast northwards from Table Bay and in the lowlands around False Bay, deposition is more important. Only in the Sandveld, where the rounded granite hills of the Kapokberg (1,511 feet), Contreberg (1,572 feet), and Dassenberg (1,864 feet) protrude through the sand is the flat surface relieved.

Although the present landscape is the product of several erosion cycles (see ch. 1, p. 21), the drainage pattern shows a striking conformity to the trend of the Cape ranges with the main rivers following the major synclines. Certain features, due to modifications of gradient, river capture and diversion initiated by post-Jurassic earth movements, and the exposure of lines of weakness, are, however, of great economic significance.[3]

The Breede river, occupying the downfold between the Langeberge and the Sonde Einde Berge, has been much influenced by Cretaceous faulting and folding. The former is primarily responsible for the steep southern slopes of the northern mountains from which, therefore, streams rush down to the main valley where their velocity is suddenly checked causing them to deposit large quantities of alluvium, which provide excellent soils for orchards and vineyards. The subsequent local flexures bringing up Table Mountain Sandstone across the course of the Breede river below Worcester created local base-levels so that the valley became divided into basins – the Worcester basin and the Robertson-Ashton lowland – separated by low ridges which the river trenches in narrow poorts.

Regional uplift in Tertiary times initiated a number of drainage changes. A vigorous northern tributary of the Breede river exploiting a line of weakness in the Table Mountain Sandstone, and eroding headwards, breached the northern mountain rim and captured the drainage of the Ceres basin. This breaching of the mountains at Mitchells Pass gave the Ceres Basin an outlet southwards, of tremendous importance to its economic development, while the presence of resistant strata, forming a local base-level, at the outlet has left the basin with a devious and sluggish drainage which facilitates irrigation.

Following this accession of drainage, however, the Breede river proceeded to lose drainage to the Klein Berg river.

The Breede river formerly drained the Tulbagh basin as well as its present valley. Its gradient, however, was lessened as a result of the Cretaceous warpings below Worcester. The Tertiary uplift increased the gradient of and gave added power to the Klein Berg river, already draining the Elands and Vogelsvlei mountains. This enabled it to cut back along a fault line into the Tulbagh basin and eventually capture the headstreams of the Breede. This had three important effects. The diversion of water augmented the flow of the Great Berg river in the Western Lowland and the breaching of the western mountains at Tulbagh Kloof – the Roodezand Pass – opened a route from the Western Lowland to the Breede valley and thence the southern coastal belt. It left the Tulbagh Basin with a well-developed river system; but the loss of its headwaters caused the Breede river to become sluggish and to braid its course, so that today much of the land in its vicinity is ill-drained and difficulties are experienced with irrigation.

Similar headward erosion by the Hex river led to its capture of the de Doorns valley drainage and the opening of an important route to the interior; by the same process the Montagu basin was accorded a southerly outlet.

The exceptionally favourable drainage conditions of the Elgin Basin should be noted; encircled by anticlinal mountains built of Table Mountain Sandstone and characterized by an undulating surface developed over Bokkeveld shales (Figs. 188 and 189) the basin is crossed by perennial streams following very devious courses so that most of the area is within easy reach of irrigation water.

The whole region experiences hot dry summers and cool rainy winters, but as a result of differences of exposure to maritime influences, altitude, aspect, and surface form marked contrasts of temperature, rainfall, and wind strength occur within comparatively short distances.

Along the west coast the prevalence of air masses originating over an ocean washed by the Benguela current causes somewhat low temperatures throughout the year, the average for summer and winter respectively being 69° and 55° F.; there is little change from day to night, the daily range varying between 10° and 15° F. Fog and low stratus cloud are frequent. These conditions are, however, restricted to the coastal strip and a few miles inland more varied conditions are experienced (see Fig. 186). Here altitude and surface form are important. In the western and southern lowlands the mean temperatures during the winter range

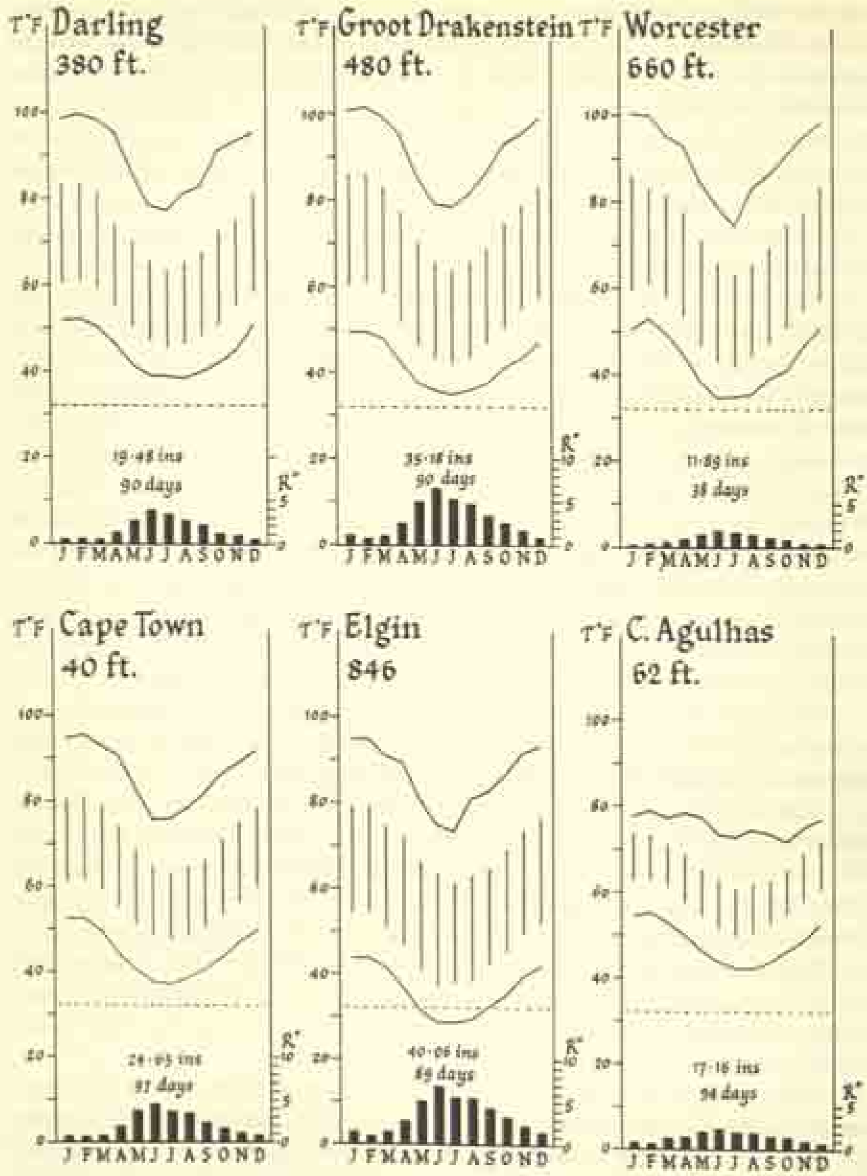


Fig. 186. Cartograms of the mean monthly rainfall, and temperature at selected stations in the South-Western Cape.

Mean daily maximum and minimum temperatures are given by the upper and lower ends respectively of the vertical lines; the continuous lines above and below represent the mean monthly maxima and minima.

from 52° to 55° F.; low night temperatures are rare – mean minima varying from 40°–50° F. – and frost practically unknown; the days are warm with average maxima between 60° and 65° F., while temperatures exceeding 75° may be experienced. In the mountain basins, however, temperatures are generally lower and subject to greater extremes. The mean temperatures are only slightly lower, about 50° F., but the nights with mean minima between 35° and 40° F. are markedly colder, the relief favouring the accumulation of cold air, and frosts are frequent. Elgin for instance has a frost period of 110 days, and Ceres one only slightly shorter. Day temperatures are similar to those in the lowlands but occasionally may reach 80° F. In the lowlands the mean summer temperatures range from 68° F. in the south and south-west to 75° F. near the Olifants river mouth. In the inland basins, where the degree of continentality is important, they vary from 66° F. at Elgin to over 70° F. in Ceres, Worcester, the Hex River Valley, and Montagu. Everywhere daily maxima range from 75° to 90° F. and temperatures exceeding 100° F. may occur inland.

The rainfall brought by frontal depressions in the westerly wind belt during winter, generally increases from an average of 20 inches in coastal lowlands to over 40 inches in the mountains but the actual amount varies with the position of the area relative to the track of the depressions and with relief. Thus the annual fall decreases rapidly towards the north-west until at the Olifants river mouth, near the northern limit of the area reached by the depressions, less than 5 inches is received. The influence of relief is naturally greatest in the mountain belt where more than 70 inches or even 100 inches fall on exposed mountain slopes while neighbouring basins and valleys receive less than 20 inches and in the case of the Breede river valley less than 10 inches. Cape Town gets 25 inches, the adjacent slopes of Table Mountain over 70 inches. Everywhere the rainfall is concentrated in winter but towards the east a little is received in the other seasons too.

Strong winds at both seasons are a characteristic feature of the climate. In winter north-westerlies associated with passing depressions may develop into violent gales. They are strongest in the coastal areas and at one time were a danger to ships in Table Bay but even in the inland basins orchards must be protected from them by windbreaks. In summer 'south-easters' occur with disagreeable regularity and may blow for days on end, producing the white cloud or 'tablecloth' on Table Mountain as the moisture condenses in the stable air forced up the mountain slope (Fig. 187). Sometimes the 'south-easter' is accompanied by a heavy dark cloud or even drizzle – the 'black south-easter'. Invariably it brings some moisture to the Cape Mountains but elsewhere it is very dry. It is strong, sometimes attaining gale force, and its desiccating effect threatens serious damage to unprotected fruit and vegetable crops. In areas bared by the the plough it causes wind erosion and soil drifting while it may delay the berthing of large passenger liners in the Duncan Dock.

Originally the south-western Cape was clothed with sclerophyllous bush

(see pp. 68–9) but today little remains. In the lowlands the land has mostly been cleared for cultivation while on the mountains recurrent fires and overgrazing have brought about changes in the vegetative cover.

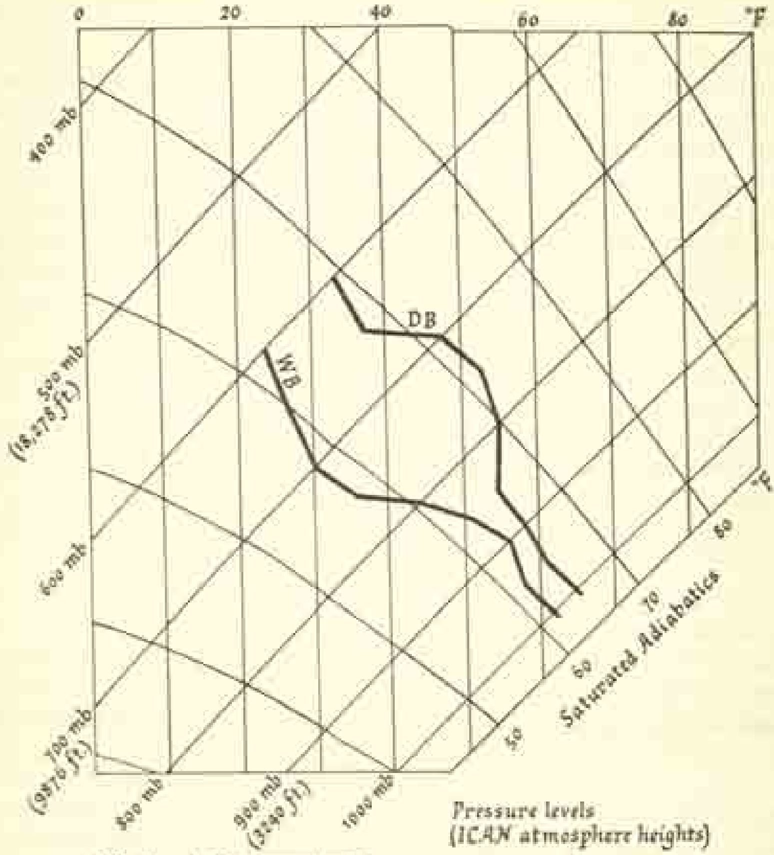


Fig. 187a. Upper air observations over Cape Town during a 'south-easter'

Note the sharp divergence of the dry bulb and wet bulb temperatures at about 3,000 feet, i.e. the summit height of Table Mountain. The cool moist air below is associated with the 'tablecloth', the south-easter cloud formed when the relatively stable air brought by the strong south-east winds is forced to rise over the mountain barrier.

The varied environmental conditions within the south-western Cape region offer opportunities for a great variety of agricultural activities, with the rearing of sheep for wool and fat-lamb production, dairying, wheat production, and fruit growing as the most important.

The livestock enterprises are largely dictated by the nature of the natural

grazing. Where typically developed the sclerophyllous bush, with its scarcity of grasses, affords only poor grazing. Better grazing was formerly available in the Southern Lowland where the occurrence of some summer rainfall encouraged the growth of a number of grasses – including the valuable redgrass (*Themeda triandra*). Burning and overgrazing, however, have destroyed many of the grasses and permitted the entry of the useless renosterbos* (*Elytropappus rhinocerotis*), a low shrub whose leaves are impregnated with wax and are unpalatable to animals. But it is now known that the seeds of this plant only germinate in bare ground exposed to the hot sun and hence it is hoped that, by burning only after the spring

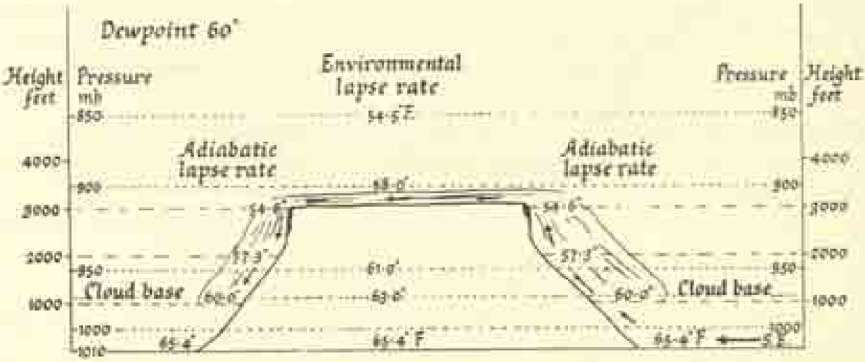


Fig. 187b. Cross section of Table Mountain illustrating the formation of the 'south-easter' cloud.

The actual observed temperatures giving the environmental lapse rate are shown in the centre; the temperatures resulting from adiabatic cooling as the air mass is forced to rise over the mountain barrier are shown at the sides; at all stages the temperature in the air mass is less than that of the surrounding air. Hence when the summit of the mountain is reached the air does not continue to rise but streams across the mountain and descends on the leeward side, thereby producing the 'tablecloth'. Normally no precipitation occurs and the cloud base is at the same height on both sides of the mountain.

rains when the grasses can grow quickly and shade the renosterbos seeds, the grassveld will be restored.[8] Grazing is also provided by the 'volunteer' grasses and other plants which take possession of the arable lands after the crops have been harvested but on lands impoverished by continuous wheat cropping the more valuable of these are being ousted by the renosterbos.

Everywhere the natural grazing provides some sustenance for sheep but is generally unsuitable for cattle. Dairying is possible only where artificial pastures of exotic grasses have been established and fodder crops are grown.

Crop production is influenced in the first instance by the climatic conditions. The generally mild temperatures coupled with adequate rainfall favour the growth of temperate cereals and vegetables during the winter months while the bright sunshine and high temperatures of early summer ensure their harvest. Because of the summer drought summer crops and fruit trees can be grown only where

* Afrikaans, renoster is rhinoceros and bos is bush.

irrigation is possible. In the lowlands the mild winter temperatures are harmful to temperate deciduous fruit treees, which should then be resting, but in the higher mountain basins conditions are favourable. Some exotic eucalypts and conifers thrive on the lower mountain slopes.

Today six categories of agricultural land use may be recognized in the region – grainland, intensively used arable land, orchards and vineyards, forestry plantations and woodland, established pastures and veld grazing.

Fig. 188. The South-Western Cape; topography and land use.

Grain production is most important in the western and southern lowlands where extensive areas of undulating relief favour mechanized operations and the lack of irrigation water precludes perennial crops. Some grain is grown on similar lands in the mountain basins but here fruit production is the main concern; the orchards are located on irrigable well-drained slopes while the valley bottoms are used mainly for vegetables. Forestry plantations have been established on the well-watered lower mountain slopes where the soils are too poor for fruit trees while strips of woodland follow the ill-drained land along the rivers. Artificial pastures to support dairy herds have been established on irrigable slopes too steep for orchards or arable crops in those mountain basins and river valleys near towns with a large demand for fluid milk. Those areas which by reason of acute relief, poor soils, inadequate or too much rainfall, have been left in natural veld.

From the standpoints of both physical environment and agricultural economy the western lowland, the southern lowland, the complex of mountains and valleys, and the Cape Peninsula and the Cape Flats form distinctive sub-regions of the south-western Cape.

The Mountains, Valleys, and Basins

In this complex sub-region fruit production is generally the main concern, but grain, vegetables, and tobacco cultivation, dairying and sheep rearing figure in the agricultural economy which is at once highly specialized yet mixed in character. Variations of climate and soil, opportunities for irrigation, and accessibility are responsible for differences of economy between the several basins and valleys.

The Elgin basin[4] (Figs. 189a and 189b) lying some 40 miles east of Cape Town, and extremely fortunate in its water supply, is the most intensively used. Formerly an important wheat-growing area today most of the land underlain by the Bokkeveld Shales is in orchards and grain crops occupy only small areas which cannot be irrigated. The frosty winters and relatively cool summers favour apple production in which this area leads the Union, accounting for about 50 per cent of the total sales for home and export markets. Peaches are second in importance while smaller quantities of pears and berry fruits are grown. Since apples and pears require greater winter chilling and prefer heavier soils than peaches the orchards show a zonal distribution. Peach orchards occupy the hill tops and upper slopes where the soils are shallow and gravelly, and they are succeeded by apples and pears as the soils become heavier and the accumulation of cold night air more pronounced towards the valley bottom (Plate 42). Vegetables, particularly onions and cabbages, and booysenberries are grown in the vlei lands (see Fig. 190) and sometimes form a lower tier in pear orchards. Recently increasing attention has been devoted to establishing pastures of introduced grasses, particularly subterranean and white clover, perennial ryegrass, Rhodes grass, fescue and Yorkshire fog on steep slopes (Plate 88) and in narrow kloofs, with the idea of maintaining dairy herds and supplying Cape Town with fluid milk. All these crops

require irrigation during the summer months. The water for this purpose is stored in small dams on individual farms (see Plate 33). Everywhere the orchards require protection from strong north-westerly and south-easterly winds and windbreaks are a feature of the landscape. (Plate 88)

The lower mountain slopes are used mainly for Government forestry plantations (Plate 90) – mainly of *Pinus insignis*, *P. canariensis* and *P. pinaster*.

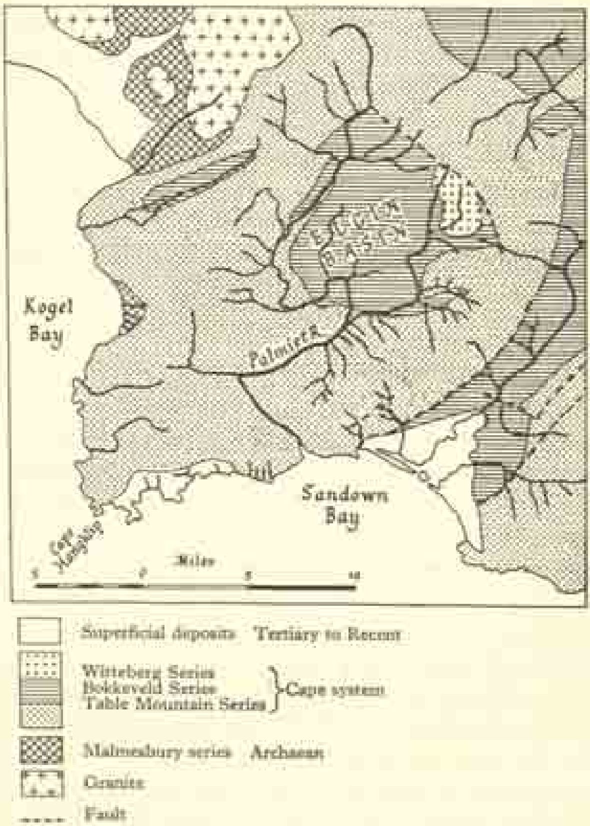


Fig. 189a. The Elgin Basin; geology and drainage.

Here also a zonal distribution is evident, with *Pinus insignis* which yields constructional timber and wood for fruit and butter boxes occupying the better soils on the lowest slopes and the less valuable but more hardy *P. pinaster* being relegated to the poorer soils above. *P. canariensis*, grown for poles, and sensitive to dry south-easterly winds, has been planted only on protected sites in the east. Since the establishment of these plantations there has been some reduction in the flow of the streams and their future extension needs care to ensure that the farmers' supplies of irrigation water are not impaired.

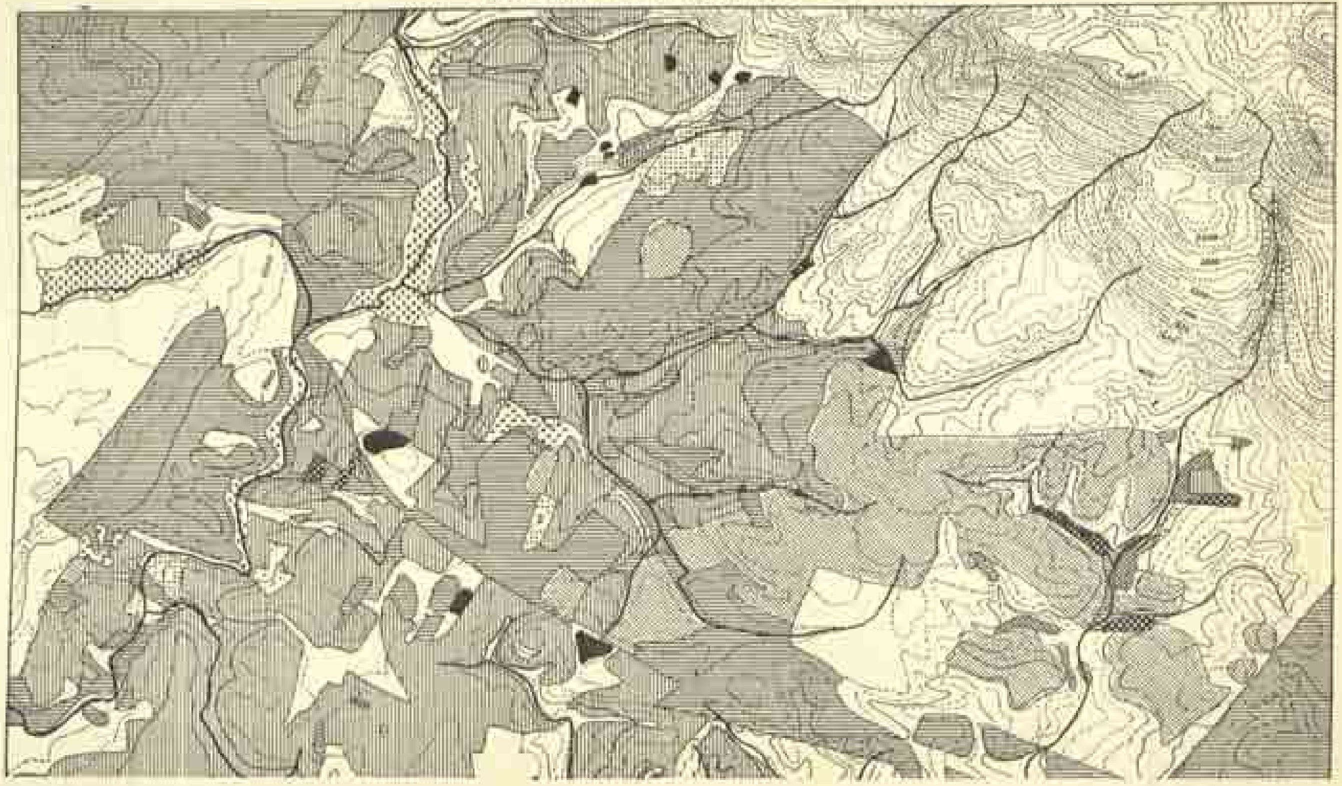
Elgin possesses a cannery and several sawmills while it has direct rail connexions with Cape Town through which much of the fruit is exported.

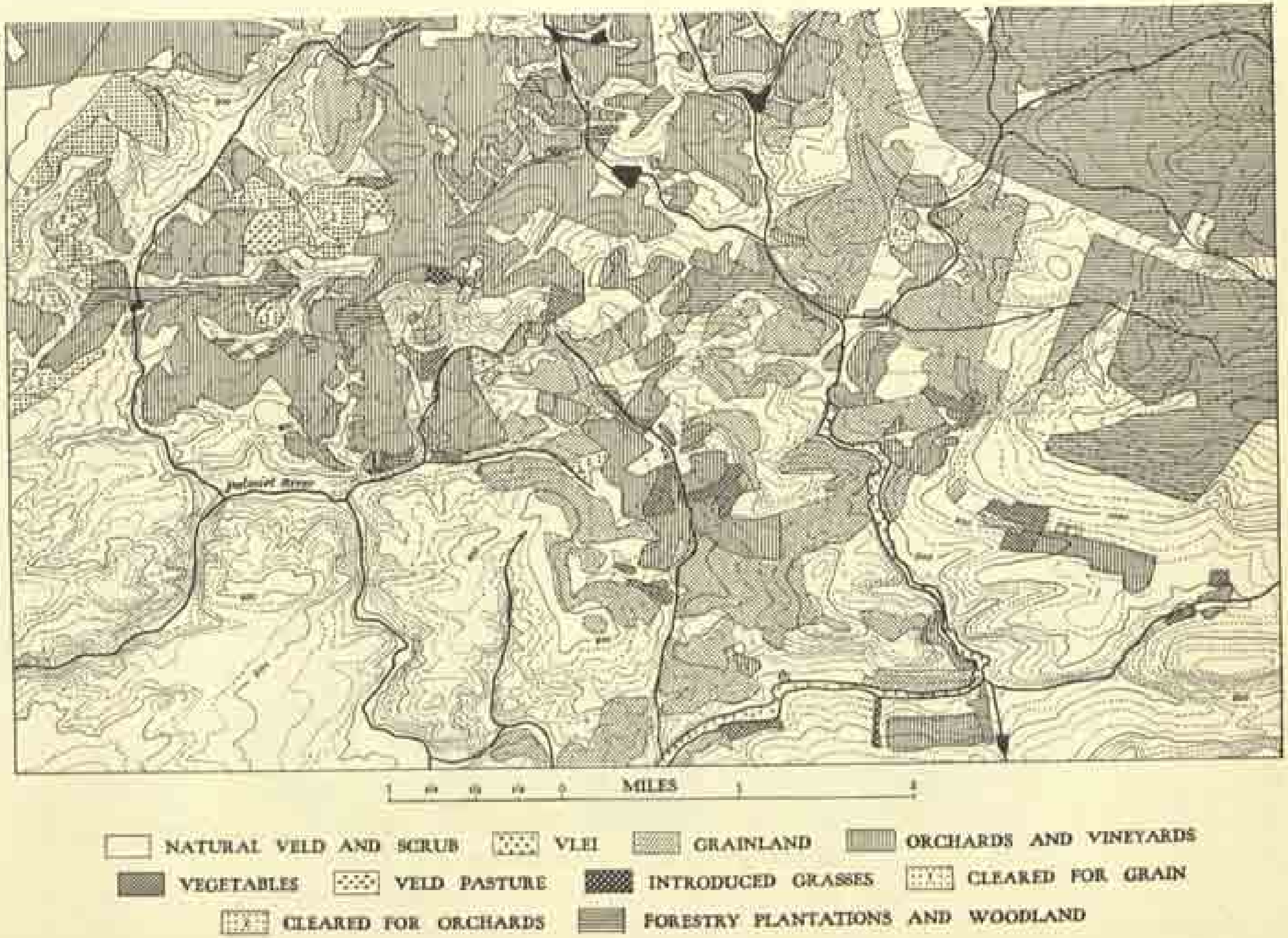
Conditions are similar in the smaller Montagu basin, where peaches, apricots, and apples are the main interests. Direct rail communications with a large urban centre or port of export are lacking, however, and much of the produce goes to processing factories at Ashton.

Fig. 189b. The Elgin Basin; relief and drainage.
(Courtesy of the *South African Geographical Journal.*)

The Ceres basin is, in some ways, similar, but it is open towards the north and east and, lying towards the interior, experiences hotter summers. The winters are cold. These conditions favour peaches and pears in the production of which Ceres leads the Union, while large quantities of apples, plums, and prunes are also grown. The main river hugs the western side of the basin and here, where it is fed by numerous tributaries from the mountains, most of the orchards are located. To the east the broad flat-topped hills are in grain-land. The lower slopes of the mountains are again utilized for forestry plantations, in this case mainly eucalypts which withstand the higher summer temperatures somewhat better than conifers. Because this basin is served only by a branch railway to the

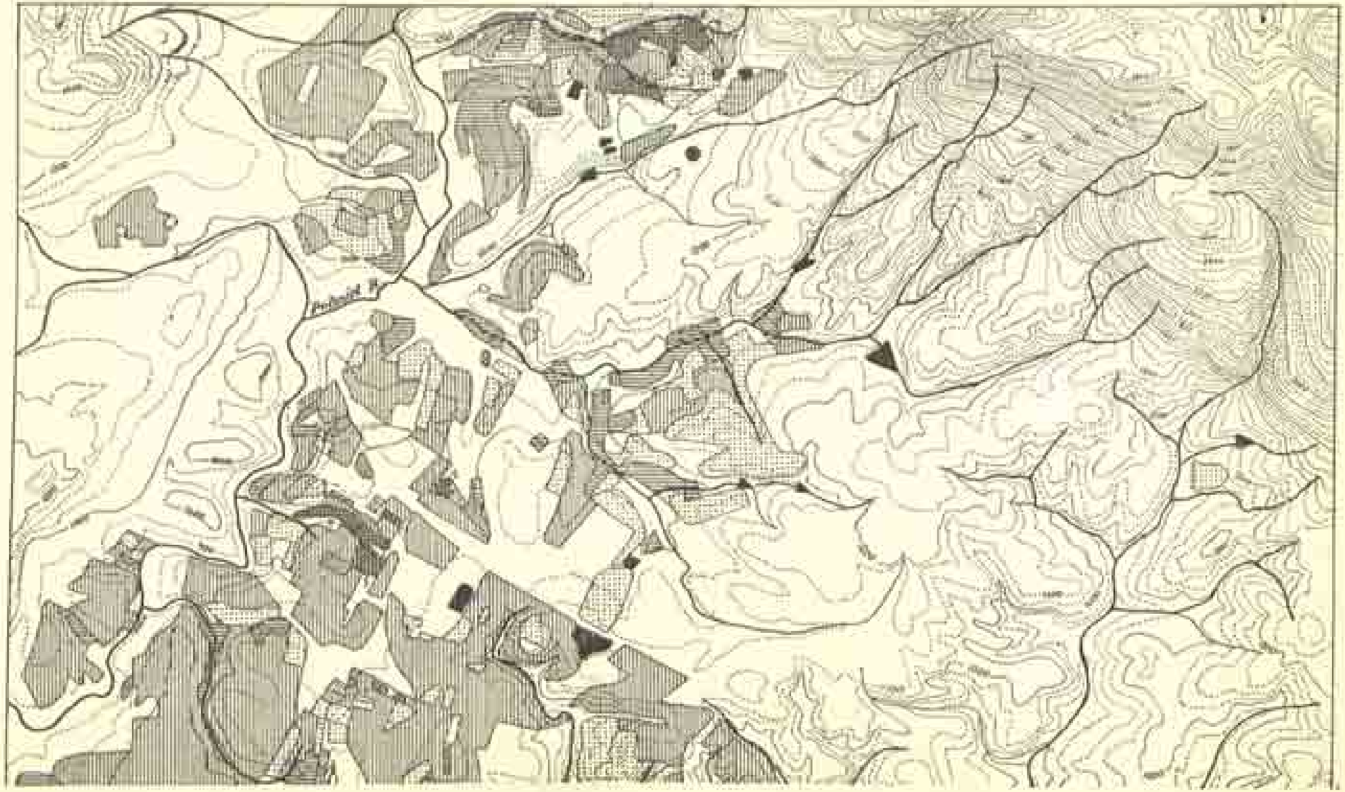
Fig. 190a. The Elgin Basin; land use.

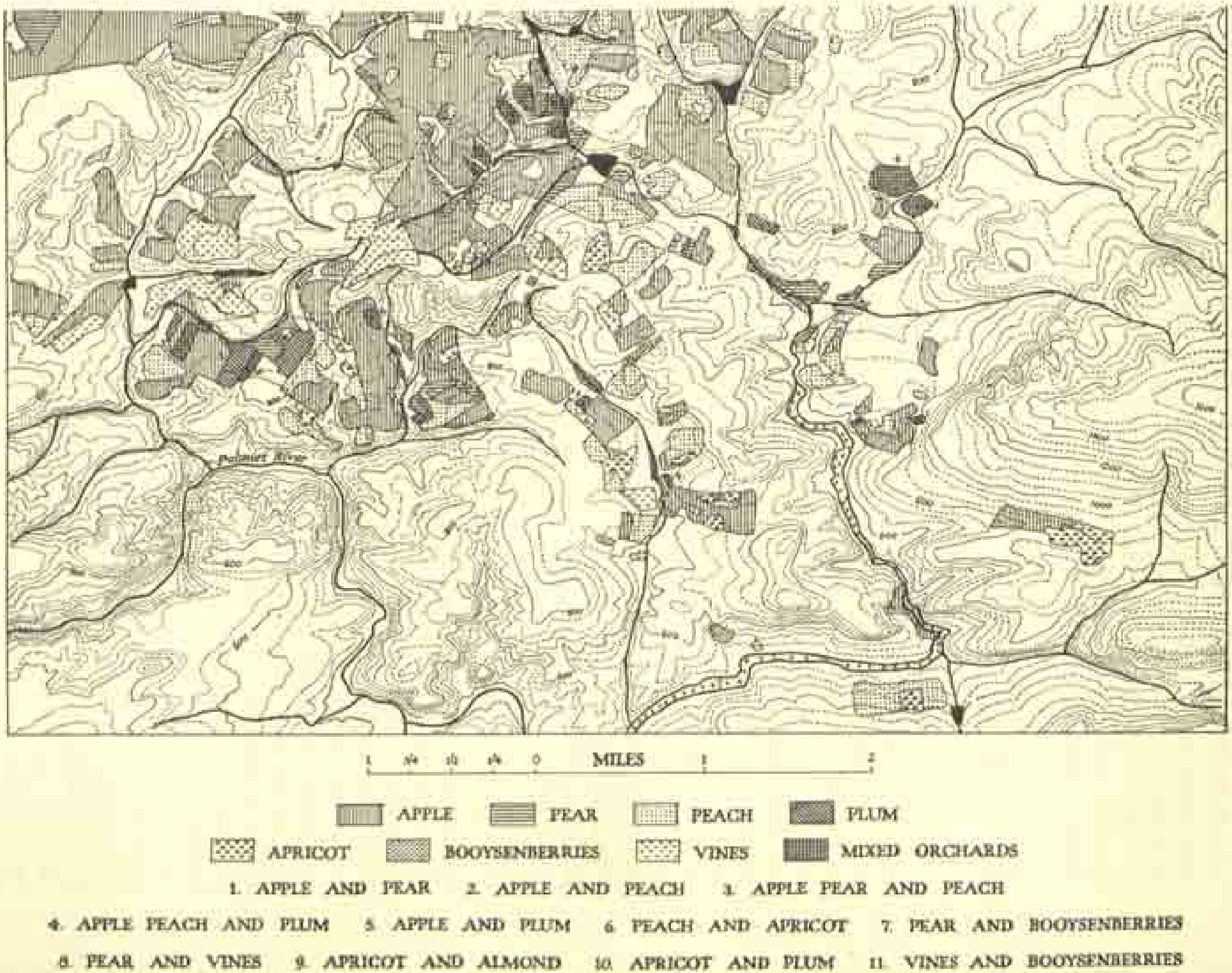




MILES
NATURAL VELD AND SCRUB
VLEI
GRAINLAND
ORCHARDS AND VINEYARDS
VEGETABLES
VELD PASTURE
INTRODUCED GRASSES
CLEARED FOR GRAIN
CLEARED FOR ORCHARDS
FORESTRY PLANTATIONS AND WOODLAND

Fig. 190b. The Elgin Basin; orchards and vineyards.




Palmer River
MILES
1 3/4 1/2 1/4 0 1 2
APPLE
PEAR
PEACH
PLUM
APRICOT
BOOYSENBERRIES
VINES
MIXED ORCHARDS
1. APPLE AND PEAR 2. APPLE AND PEACH 3. APPLE PEAR AND PEACH
4. APPLE PEACH AND PLUM 5. APPLE AND PLUM 6. PEACH AND APRICOT 7. PEAR AND BOOYSENBERRIES
8. PEAR AND VINES 9. APRICOT AND ALMOND 10. APRICOT AND PLUM 11. VINES AND BOOYSENBERRIES

main Johannesburg–Cape Town line and because it enjoys hot dry summers, which facilitate fruit drying, large quantities of the more perishable fruits – peaches, pears, and prunes – are prepared in this way.

The climate of the Hex river valley, particularly around de Doorns, resembles that of Ceres, but direct access to the main Kimberley–Cape Town railway favours the production of dessert fruit for export markets. This area provides nearly 50 per cent of the Union's grape exports and large quantities of pears. Winter snow on the neighbouring mountains delays the summer with the result that the fruit ripens later than elsewhere, thereby avoiding the peak production period and fetching high prices.

The Tulbagh basin provides the transition between the mountain basins and the Breede river valley. Its summers are very hot and dry and only about 20 inches of rainfall come in winter. Drained by the Klein Berg river the greater part of the valley is underlain by Malmesbury beds and the soils tend to be heavy. The main line railway passes to the south. Apricots, plums, prunes, and peaches are grown principally for drying, but the soils are more suitable for cereals; wheat is widely grown, particularly in the south where, however, downslope ploughing has left its legacy of sheet and gully erosion; when prices are good, Turkish tobacco is produced; for this, labour is less difficult to obtain than near Cape Town, but the yields are lower and the quality of the leaf inferior to that of the Helderberg. To the south of Wolseley the basin is actually drained by the Breede river, but forms part of the structural unit drained by the Klein Berg. Orchards, protected by the high mountains to the west, cover a considerable area along the river while extensive plantations of pines and gums clothe the mountain slopes.

The Breede river valley contrasts sharply both with the mountain basins and with the other valleys of the south-western Cape. It offers many advantages for agriculture. It is broad and, due to the preservation of a great variety of rocks ranging in age from Bokkeveld to Cretaceous, it possesses a great variety of soils. It is, however, an arid area, receiving little more than 10 inches of rainfall and experiencing great extremes of temperature particularly in summer when excessively hot days are frequent. Irrigation is therefore of supreme importance. For this purpose favourable conditions exist on the northern side of the valley, where the first order tributaries coming from the mountains are used to irrigate orchards, mainly apricot, and vineyards which have been established on the fertile alluvium. Elsewhere conditions are less favourable. The main river is sluggish and braids repeatedly, the land in its vicinity is ill-drained and subject to flood. It is difficult for individual farmers to lead water from the main river on to the good lands. As yet the valley is served by only one irrigation scheme supplied from Brandvlei dam (see ch. 7, p. 147). Not only is this inadequate for the needs of the valley but the main furrow to Robertson is 30 miles long and the loss of water by evaporation amounts to 35 per cent. At present a new dam site is being sought in Mitchells Pass to serve the western part of the valley but another to supply the

eastern part is also necessary. Meanwhile the Breede valley remains underdeveloped. Intensive farming is restricted to a few favourable areas served by major tributaries as around Rawsonville, Worcester, and Robertson. Here large quantities of fruit are produced, and sent mainly to the canning and jam factories at Worcester and Ashton. Elsewhere the rearing of sheep is the only activity. Timber plantations are not important for the lower mountain slopes are steep and dry.

The Great Berg valley was the scene of early Dutch settlement in the Cape and today its attractive cultural landscape dignified by many old farmhouses with their traditional Cape Dutch gables is very largely a reflection of the length and prosperity of its occupance. In this it contrasts with the valleys so far considered.

The headstreams of the Great Berg river rise in the mountains near Fransch Hoek, where a comparatively low watershed separates them from the drainage to the Sonde Einde river. The numerous tributaries have a steep gradient and are etching their way into the mountains, but the trunk stream exhibits the features of great age, even near its source being flanked by broad flat stretches of alluvium. In the western lowland near Paarl its gradient is very gentle and, fed by high rainfall in the mountains, the river is liable to flood and change its course. For this reason much of the land in the immediate vicinity of the river, often stony or sandy, is left to natural bush while flood control is necessary in order to protect the orchard and grain land on either side. Otherwise the valley is very favourable for intensive agriculture. There is plenty of water for irrigation purposes both from the main river and its numerous mountain tributaries and the climate is ideal for fruit cultivation. Along the river there are a number of fertile alluvial benches while the granitic slopes above provide well-drained light loamy soils. The summers are hot with means exceeding 75° F. and maxima averaging 85° F. The winters are mild with mean temperatures around 54° F., and minima over 40° F. Hence only those fruits requiring little chilling are grown; vines, apricots, and peaches take up most of the land, the orchards stretching away to the Drakenstein mountains in the east and clinging to the slopes of the Paarl Berg on the west. On the lower benches some wheat and a little Turkish tobacco is grown. Along the rivers there are some timber plantations, mainly eucalyptus or poplar, while on the lower slopes of the mountains conifers are grown. A large proportion of the fruit is exported for dessert purposes for the main Mafeking-Cape Town railway traverses the valley, some is dried and the canning and jam factories at Wellington and Daljosaphat take increasing quantities. In addition wine making is traditional in the area and some of the best South African brandies, sherries, and table wines are made in Paarl. North of Wellington the mountains recede, and receive less precipitation while fewer streams flow from them; the Malmesbury beds occur at the surface and the soils tend to be heavier; and orchards give way to grain cultivation.

In its upper reaches the Eerste river occupies a deep narrow valley cut into the Younger Cape Granite, above which krantzes of Table Mountain Sandstone

tower on either side; this section, known as the Jonkershoek valley, is famed for its protected flora and for the excellence of the trout fishing and is much frequented by climbers, naturalists, and anglers. Below the mountains the river crosses rolling country developed on granite and Malmesbury slate. Due to proximity to the sea and low elevation the winters are warmer than in the valleys and basins hitherto considered (with mean temperatures around 55° F. and little likelihood of frost), while the summers are several degrees cooler. The climate therefore is not very favourable for deciduous fruits other than vines, while water for irrigation is available only near the mountains. Vineyards occupy most of the land, while plums, pears, and peaches are grown on the valley slopes around Stellenbosch. Where the land is level the heavier soils derived from the Malmesbury beds are used for grain crops, while the light sandy loams of the granite in the Helderberg–Stellenbosch–Elsenburg area support the most important Turkish tobacco growing area in the country (see ch. 11). The crop flourishes without irrigation and the sea influence results in a high-quality leaf.

The Cape Peninsula forms an outlier of the mountain and valley subregion. Here the Table Mountain Sandstone, disposed in a gentle syncline, forms a flat-topped plateau bounded by precipitous krantzes best exemplified in Table Mountain itself, while the granite or Malmesbury beds form the gentle rounded slopes below. On the plateau top the drainage is sluggish and ill-defined, but on reaching the edge the streams cut deep and narrow ravines which provide the hiding places of wild disas and other beautiful Cape flowers; in the south the shady kloofs reach down to the sea but below Constantia the streams become lost in the drift sands which cover the Cape Flats to the east.

The greater part of the Cape Peninsula is wild and rugged and of use only for those seeking enjoyment in its magnificent coastal and mountain scenery. Only the Constantia valley and the Hout Bay valley are of any agricultural significance. The former, enjoying the protection of Table Mountain and Constantia Berg, has long been famous for its vineyards. Today large quantities of table grapes are produced and sent to nearby Cape Town for export, but every year residential development claims agricultural land and the days of the Constantia vineyards are numbered. Level land suitable for housing is scarce in the environs of Cape Town while the sandy wastes to the north and east are windy and unattractive. Hence the conflict with agriculture. The Hout Bay valley, sheltered by the Karbonkelberg, possesses a small area of land sufficiently level and well-watered for vineyards and vegetable production. As elsewhere the lower slopes of the mountains have been planted to conifers and eucalypts, but while the trees on protected sites are flourishing, those exposed to the winds along the shores of Hout Bay show only poor growth.

The Western Lowland

Here the agricultural economy is centred around wheat production but differences in the surface features, rainfall, and soils and in access to markets introduce

modifications which distinguish the Swartland, the Sandveld, and the Cape Flats.

In the Swartland[5] (Plate 92) practically all the land is cultivated and natural vegetation remains only on very poor soils, and in kloofs too steep for the plough. The farms average around 800 morgen of which about 270 morgen are used for grain crops and 340 morgen are rested every year.[6, 7] Wheat is the most important crop, bringing in about 70 per cent of the farm income, while oats and other cereals are grown in rotation. Although natural grazing is scarce about 400 sheep are usually kept, and near the towns and the main railway and road to Cape Town dairy herds are increasing. The sheep graze on the volunteer crops which take possession of the old lands in winter and off the stubble from harvest time until February, but February to May and August to September are periods of scarcity. Formerly the sheep were kept mainly for their wool, which was of rather poor quality but recently there has been a trend towards fat-lamb production which is better suited to the geographical conditions. Autumn is the lambing season and in order to provide feed at this time lucerne, which sprouts after the first rains, is grown in the cool kloofs. The lambs are fattened on the stubble and grain, mainly oats, after harvest and the flocks reduced to a minimum during the season of scarcity. Mules are kept as work animals.

Because of the lower rainfall the farms in the Sandveld are much larger, averaging around 1,700 morgen. Of this, about 640 morgen is cultivated while the remainder, because of thin soils or liability to wind erosion, is in veld grazing. This, however, is poor and livestock activities depend largely on stubble and volunteer grasses on the old lands. Wheat is the main crop accounting for 50 per cent of the farm income, while, due to low rainfall and light soils, rye is more important than oats in the rotation. Livestock activities are more important than in the Swartland. The sheep flocks are about the same size, but more dairy herds, mainly Friesland, are kept especially around Darling, where there is a creamery. Goats are also important, and mules are kept for draught purposes.

The Cape Flats lying to the east of the Cape Peninsula comprise a sandy lowland, crossed by slow moving streams which have difficulty in breaching the coastal dunes in the south and hence open out into large vleis and lakes, providing opportunities for yachting. A century ago the area was, as a result of the destruction of the native bush by cutting for firewood, a wilderness of drifting sand and moving dunes but large areas have been reclaimed by planting with marram grass (*Psamma arenaria*) and pypgras (*Ehrharta gigantea*) followed by indigenous and exotic shrubs (Plate 95). Today shrub associations dominated by the Australian acacias – Port Jackson Willow (*A. saligna*), Rooikransbos (*A. cyclopis*), and Golden Wattle (*A. pyncantha*) – cover large areas, but scattered throughout the area are dairy farms (Plates 97 and 98) and vegetable farms (Plate 96) supplying the urban market in Cape Town with fluid milk and fresh produce, while on the western side grape farms, displaced by residential development in

Constantia, are extending. Crops are raised in small plots, protected on all sides by windbreaks of Port Jackson willow. Cultivation is intensive, rotation is practised and the light permeable soils, naturally rich in lime and phosphates, kept well supplied with organic matter by regular dressings of manure and compost. Wheat and tobacco are grown in rotation with vegetables and the high level of soil fertility results in good yields. Throughout the Cape Flats are numerous shacks or 'pondokkies' of the Coloured people and since the water table is near the surface, much of the area becomes flooded after heavy winter rains and considerable distress results.

Around the granite and sandstone masses rising from the lowland, the soils are generally lighter than elsewhere and less suited to cereal production, while the streams issuing at the geological junctions provide irrigation water. On the eastern margins, where there is protection from strong north-westerly winds, vineyards flourish, particularly in the Constantia valley and near Paarl and Riebeeck West.

The Southern Lowland

Owing to the longer rainy period the veld grazing is better in the Southern Lowland where the agricultural economy centres on wheat and wool production; the relative importance of wool increases eastwards where the longer rainy season provides better year-round grazing but less suitable conditions for wheat. Three districts may be recognized, the Rûens, the Lower Langebergen, and the Duineveld.

In the Rûens (Plate 93) the farms, averaging just over 700 morgen, are smaller than in the Swartland, although they normally include a large proportion of uncultivated land, mostly mountain range, stony hills, and exhausted lands. The grazing, although better than in the Swartland, is poor and scarce during the spring months. Renosterbos and Klaaslouwbos have taken possession of much of the old land. Despite the danger of rust and foot-rot disease, due to wet springs, wheat is an even more important source of cash income than in the Swartland, mainly because there are a large number of share croppers operating small holdings devoted entirely to crop production. The owners combine crop production with livestock farming. The rotation is a close one: wheat, oats or barley or perhaps rye, and fallow. Farming is mechanized and few work animals are kept. Cattle are unimportant for the distance from markets discourages dairying and the natural grazing and steep slopes are more suitable for sheep. Moreover many of the farmers own veld grazing land in the dune sand and limestone belt along the coast; this is used during winter, the animals being brought to the Rûens to feed on the stubble after harvest. Such movements are more easily carried out with sheep than with cattle. The sheep, merinos, are kept for their wool, which is of excellent quality and fetches much higher prices than is obtained by Swartland farmers. Until recently there was a tendency towards increased concentration on wheat production, but now the pendulum appears to have

swung back in favour of wool and it is hoped that farming will become more mixed in character.

The Duineveld receives less rainfall than the Rûens, but the humidity is high throughout the year; extremes of temperatures are rare. Farms are smaller than elsewhere in the lowlands, averaging less than 600 morgen of which nearly 500 morgen is in grazing. Grain and wool production are again the chief concerns; wheat does less well than in the Rûens, but is the most widely grown crop, followed by oats, which is more important than elsewhere. On the light sandy soils near the coast there are a number of small farms, less than 250 morgen in extent, specializing in the production of onions, potatoes, and sweet potatoes.

The Lower Langebergen continues the main surface features of the Rûens and the Duineveld but the rainfall is more evenly distributed throughout the year with maxima in spring and autumn. Wheat production is therefore precarious and the area, endowed with good natural grazing, has always been one devoted to sheep farming. High wheat prices, however, encouraged share-croppers from the Rûens to extend their operations into this area with the result that much good grazing land has been ploughed up. Today wheat brings in the main cash income, but the area is marginal for this crop and better suited to sheep farming; it will be difficult, however, to revert to the latter enterprise, particularly as ploughing has destroyed the natural grazing plants.

The south-western Cape is essentially an agricultural area but industries concerned mainly with the processing of agricultural products are of increasing importance. They are located in four centres – Cape Town, Paarl-Wellington-Daljosaphat, Worcester, and Ashton. In all fruit canning and jam manufacture are important. Paarl is renowned for its wines and brandies and also grades tobacco and manufactures cigarettes. Worcester,[8] which commands the route to the interior via the Hex river pass, and is the natural focus for the Breede valley and the mountain country, has light engineering and wool textile industries and promises to become an important industrial centre. Cape Town has a variety of industries, some of them notably clothing, boot and shoe manufacture, food processing and engineering of national importance, and others simply to meet the needs of port and city.

The region also enjoys a flourishing tourist industry which caters for visitors from the Rhodesias and overseas as well as from other parts of the Union. Where the sea washes against Table Mountain Sandstone or granitic rocks there is magnificent coastal scenery characterized by a succession of promontories enclosing small bays. The fashionable resorts are on the Atlantic side of the Cape Peninsula where the sea, influenced by the cold Benguela current, is chilly for bathing; the popular centres are on the False Bay side where the sea is warm. Most famous are Muizenberg, where drift sands, lapping up to the Table Mountain Sandstone, provide fine beaches and the shelving sea-bed breaks the waves of

the ocean to produce excellent surf bathing, and Fishhoek, where sands link the two upland portions of the Peninsula.

On the eastern side of False Bay, Hermanus is renowned. All round the coast wave-cut rock platforms at elevations of 60 feet and 20 feet offer respectively sites for holiday resorts and jetties for anglers. The fishing industry is also important (see ch. 16, p. 272). Cape Town is the big fishing port, but in addition each bay sends out a number of small boats, Kalk Bay and Hout Bay being most

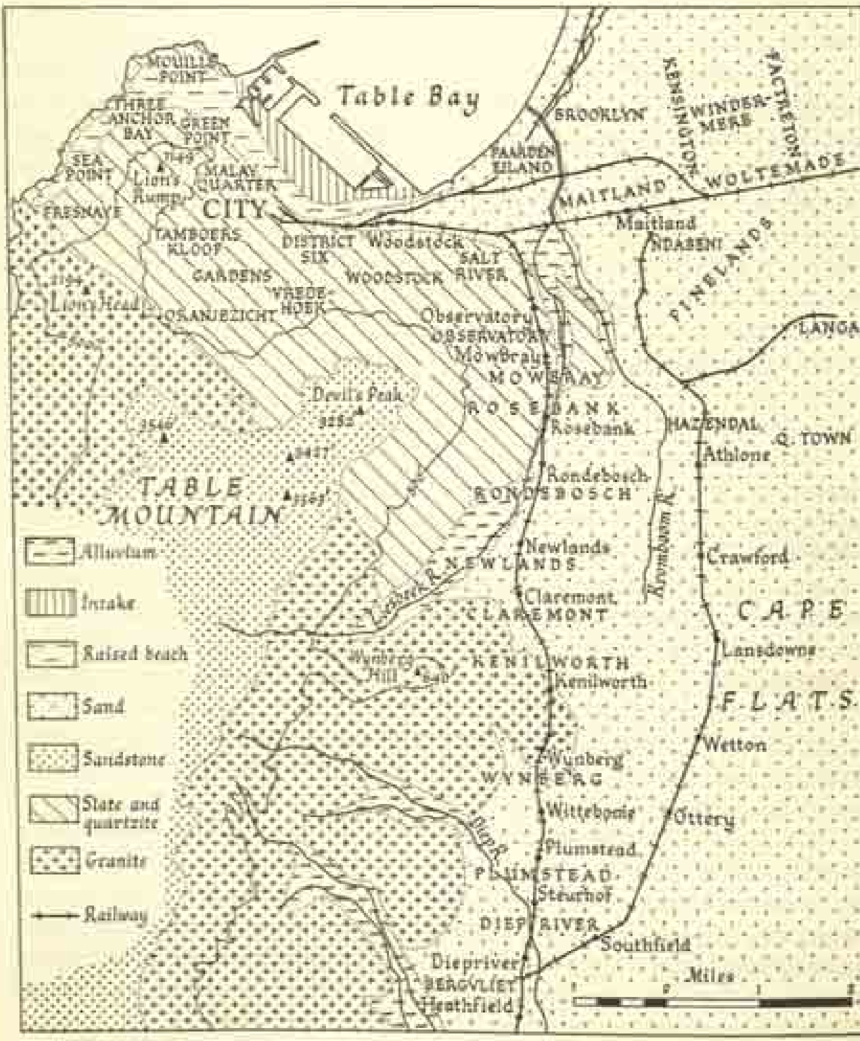


Fig. 191. The site of Cape Town; geology and topography.
(After P. Scott, courtesy of the *Geographical Journal*.)

important. The latter is especially important for crayfish and has processing factories. Saldanha Bay serves as a whaling station.

The population is unevenly spread throughout the south-western Cape. The mountains are uninhabited, the lowlands carry relatively few people. The concentrations occur in valleys and mountain basins, particularly around the small industrial towns, while Cape Town, which is now a commercial and industrial centre as well as a port and the seat of Parliament, has become a large city spreading its tentacles into the neighbouring agricultural areas.

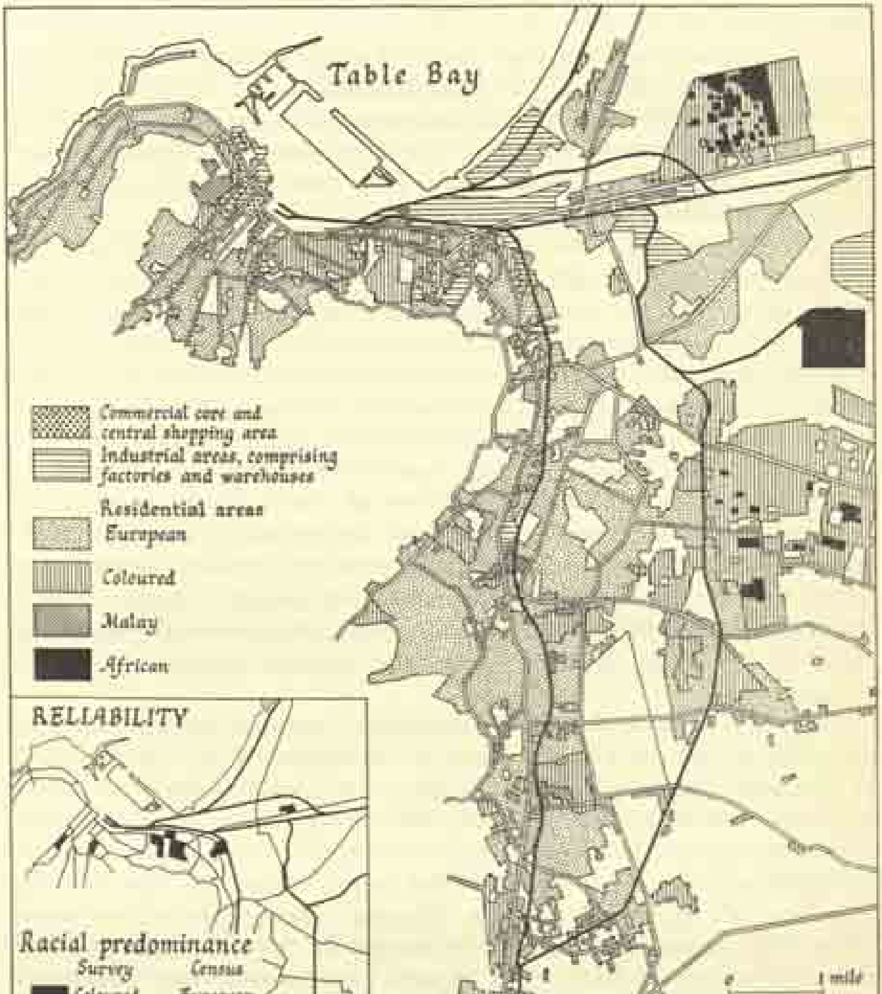


Fig. 192. Cape Town; urban land use.

(Compiled and amplified from maps of P. Scott, courtesy of the *Geographical Journal*.)

Cape Town is justly renowned for the beauty of its setting (see Plate 75). The heart of the city – and the site of the first settlement – lies in the Table valley above which tower the precipitous krantzes of Table Mountain. It is sheltered from the 'south-easters' by the massive Devil's Peak and from the north-westerlies by the lion-shaped ridge bearing the names of the Lion's Head and Lion's Rump. As the mother city, as Cape Town proudly calls itself, has grown from the halfway house to India, the Tavern of the Seas, to become the great national port, seat of Parliament, and industrial and commercial centre of today, its urban pattern has been directed and moulded by physical features.

The first settlement was neatly contained on the relatively level land of the Table valley where the Dutch East India Company marked out the land outside the walls of their fort in a rectangular fashion to ensure that the houses built by the Burghers should have some order.[9] Growth was slow, the settlement numbering only 14,000 people, of which about 4,000 were Europeans, in 1795, and development orderly.

Under British rule, however, the picture changed. During the first half of the nineteenth century, settlement spilt over on to the raised beach at Seapoint and up the gentler slate and granite slopes of the mountains between Fresnaye and Wynberg to a height of 500 feet (see Fig. 191). With the growth of trade associated with the opening of the Kimberley diamond mines and the Witwatersrand gold mines, the population increased rapidly and the town expanded in a sprawling fashion, the shifting sands of the Cape Flats, however, limiting development in an easterly direction. The lower mountain slopes with their cooler healthier climate, better-drained sites, and commanding views of coastal and mountain scenery naturally attracted the wealthier people while the land along the railway which, keeping to the foot of the mountains, was opened to Wynberg in 1864 and to Simonstown in 1890, was taken up for middle class housing. The poorer people lived near the port with the Coloured folk concentrated near the Castle and on the slopes of Signal Hill. Residential segregation on racial grounds had become apparent.

The close of the Anglo-Boer war introduced a period of sustained and rapid growth as the port traffic increased with the development of the near hinterland in the south-western Cape and the far hinterland in the Transvaal and various industries were attracted to the town. Between 1904 and 1951 the European population nearly doubled – from 103,887 to 186,660 – while the number of Non-Europeans increased fourfold – from 65,754 to 254,265. The changing functions of the town and the changing composition of its population were naturally associated with changes in the urban pattern. The eighteenth-century Dutch town became increasingly the commercial centre with a tendency to grow upwards rather than outwards, while the lack of any relationship between it and the nineteenth-century sprawl outside it led to increasingly serious traffic congestion. Eastwards light industries, notably food

preparation and clothing manufacture, penetrated into a belt of residential deterioration along the railway and Lower Main road to the southern suburbs while heavier industries – including engineering, soap and paint manufacture – were established on industrial sites on reclaimed sand flats along the railways leading from the port inland notably at Paarden Eiland, Salt River, Ndabani, and Epping.

With the growth of industry around the commercial centre the European population moved out, the wealthier to commanding sites on the mountain slopes, the middle class to sites near the railway to Simonstown and to new suburbs served by a new railway line on the Cape Flats, where Pinelands was created as a garden city as early as 1920.

In the areas of residential deterioration invaded by industry the Coloured people moved in as the Europeans moved out, in some cases actually precipitating their withdrawal. In one tract of Salt River, where the European population decreased by 32 per cent during the 1936–51 period the Coloured population increased by 42 per cent and the Indian population multiplied fourfold.[10] In some areas the density of population is now over 200 people per acre. In these appalling slums tuberculosis is rife. Recently sub-economic housing estates have been built on the Cape Flats for the Coloured people while attempts have been made to replace the pondokkies – hovels built of wattle and daub, of wood and hessian or petrol drums and corrugated iron – of the shanty town at Windermere by more permanent houses also let at sub-economic rentals.

The Africans are supposed to live only in Langa which was created in 1923 in compliance with the Act of Parliament compelling all urban Africans to live in locations. Because building construction has not kept pace with the growth of the urban African population since the war, however, more than four-fifths of the African population live outside the township, mostly in Coloured areas where they contribute further to the squalor and to the incidence of tuberculosis.

Since the war the reclamation of the foreshore following the completion of the Duncan Dock (see pp. 500–1) has provided land for the redevelopment of the central congested areas. Notably the shifting of the railway station and goods yards on to the new land has permitted an extension of the commercial area while the construction of new approach roads from the suburbs has alleviated the traffic congestion. The most serious problem remains that of housing the Non-European population and it remains to be seen to what extent the operation of the Group Areas Act and the building of new housing estates can arrest the spread of Coloured people into decayed European areas and of urban blight outwards from the centre.

Today Cape Town consists essentially of six zones (see Fig. 192). The commercial centre occupies the old rectangular Dutch town and is flanked on the east and west by areas of deteriorating buildings invaded by industry and by Coloured folk. Beyond, the lower mountain slopes carry fine residences and the land at their foot the houses of the middle class. Eastwards again lie the main

industrial belts and the area of new housing estates on the Cape Flats where level land has permitted unrestricted urban sprawl.

Against a beautiful setting the modern Cape Town, while containing much of historic and aesthetic value, suffers more from the ugliness and lack of planning of the late nineteenth and early twentieth centuries than any other South African city. It remains to be seen to what extent present planning can provide the order and dignity worthy of the setting.

BIBLIOGRAPHY

1. See A. L. du TOIT. *Geology of South Africa*, 3rd edition edited and prepared by S. H. HAUGHTON. Edinburgh. 1954.
2. See M. S. TALJAARD. 'Morphological and hydrological aspects of the Tulbagh–Swellendam mountain foreland with special reference to the social and economic significance of the surface water resources'. *S.A.G.J.*, Vol. XXXIII, 1951, pp. 38–51.
3. C. L. WICHT. *Report of the Committee on the Preservation of the Vegetation of the South-western Cape.* Special publication of the Royal Society of South Africa. 1945.
4. See M. M. COLE. 'Elgin. A land utilization survey'. *S.A.G.J.*, Vol. XXXI, 1949.
5. See W. J. TALBOT. *Swartland and Sandveld, A Survey of Land Utilization and Soil Erosion in the Western Lowland of the Cape Province.* O.U.P., Cape Town. 1947.
6. See Union of South Africa, Department of Agriculture, Division of Economics and Markets. *Agro-Economic Survey of the Union* (11), *The Five Cropping Regions of the Winter Rainfall Area.* Dept Agric., Bull. No. 275, 1949.
7. See J. C. NEETHLING. *A Comparative Study of Wheat Farming in Four Sub-Areas in the Winter Rainfall Crop District of the Union of South Africa.* Dept Agric., Bull. No. 227, 1944.
8. See A. NEL. 'Worcester: 'n proefneming in funksionele differensiasie'. *S.A.G.J.*, Vol. XXXIV, 1942.
9. See MARGARET MARSHALL. 'The Growth and Development of Cape Town'. *M.A. Thesis*, University of Cape Town, 1944 (unpublished).
10. PETER SCOTT. 'Cape Town: a multi-racial city'. *G.J.*, Vol. CXXI, Pt 2, 1955.

37

The South-eastern Cape

In structure and surface features, climate and vegetation, agriculture and settlement the country lying between the twenty-fourth meridian and the Great Kei river and between the coast and the Great Escarpment is a transition zone. It has, however, acquired some sort of unity from its history as a buffer zone and from the influence of its two major ports, Port Elizabeth and East London.

The south-eastern Cape is the meeting place of two major physiographic provinces – the Cape Folded Belt and the Eastern Plateau Slopes (Fig. 195). In consequence there is a considerable diversity of surface form which in turn is associated with variations of climate and vegetation.

In contrast to their magnitude further west, here the ranges of the Cape Folded Belt become lower and finally merge into a coastal plateau which reaches the sea between Cape St Francis and Port Alfred. Only two headlands dignify the coast – the one where the Karreedouw ridge, representing the eastern extremity of the Langebergen, merging into the coastal plateau at an altitude of about 500 feet, forms Cape St Francis and the other where the Elandsberge similarly continued into the coastal plateau forms Cape Recife. The northern ranges are higher than the southern ones but the highest point in the Suurberge is only 2,400 feet and the range declines to the level of the coastal plateau (400 feet) west of the Great Fish river mouth. The evidence indicates that the ranges were planed down during a period of marine transgression and then covered with Cretaceous and Tertiary deposits. Subsequent erosion has removed this cover from the major ranges which became higher westwards, i.e. with increasing distance from the cover. Thus today two physiographic units are recognizable – the folded mountains, with the Witteberg quartzite building the northern ranges and the Table Mountain Sandstone the southern ones and the coastal platform partially covered with Cretaceous and Tertiary sediments (Fig. 193). The distinction between them is sharpened by a major fault paralleling the southern sides of the Groot River Heights and the Suurberge.

North of the Witteberg ranges the surface features are the product of the retreat of the Great Escarpment (see ch. 1, pp. 22–4). The country, underlain by

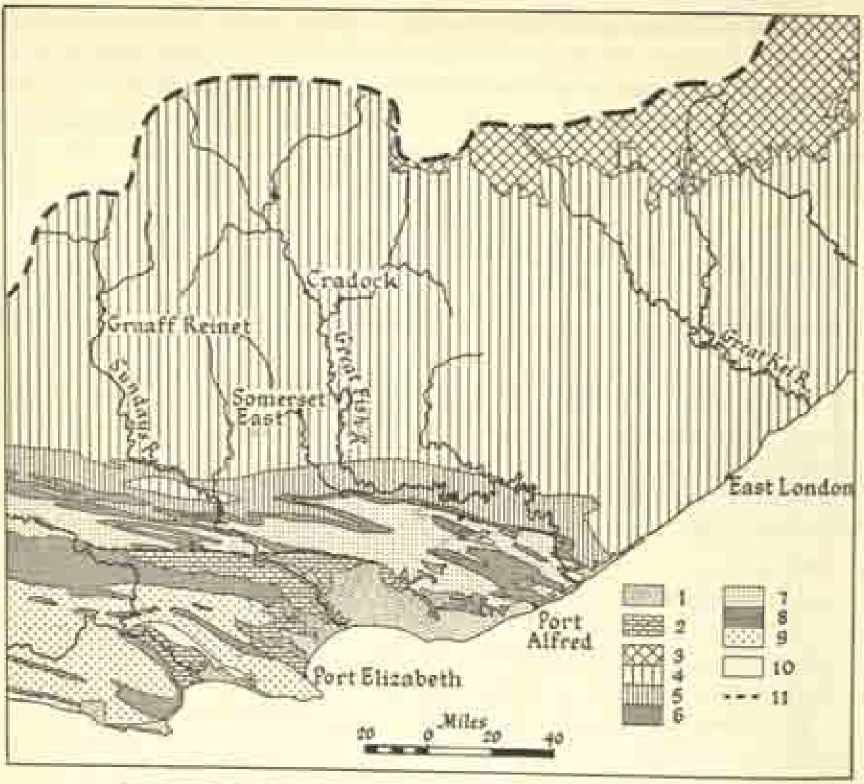


Fig. 193. The South-Eastern Cape; geology and drainage.

1. Unconsolidated superficial deposits of Tertiary to Recent age. 2. Conglomerate, sandstone, shales and limestone of Cretaceous age. 3. Sandstones of the Stormberg Series of the Karoo System. 4. Shales and sandstones of the Beaufort Series of the Karoo System. 5. Mainly shales, some sandstones of the Ecca Series of the Karoo System. 6. Tillite of the Dwyka Series of the Karoo System. 7. Sandstones of the Witteberg Series of the Cape System. 8. Shales of the Bokkeveld Series of the Cape System. 9. Sandstones, quartzites of the Table Mountain Sandstone Series of the Cape System. 10. Shales of Loskop and Malmesbury age. 11. Worcester fault.

Karoo rocks, is divided into two by the well-defined orographic line of the Tandjesberg, Groot Winterberg, Amatola mountain, and Kologha mountain (Fig. 195) which marks a former limit of the Great Escarpment.[1] To the south the surface, rising from an elevation of 200 to 300 feet at the coast to 2,000 feet towards the interior, is comparatively flat (Fig. 194) and apart from deeply entrenched valleys, in places more than 1,000 feet below, featureless. To the north it is more broken and comprises a series of level basins along the major tributaries of the Great Fish and Great Kei rivers, separated by lines of table-topped kopjes, frequently capped with dolerite, representing relict remnants of the plateau.

The major rivers flow south-eastwards. They probably originated on a sur-

face of Karoo rocks and later extended their courses across the emergent Cretaceous and Tertiary sediments. Subsequently the Sundays river uncovered the rocks of the Cape ranges, and in maintaining its course became superimposed upon them while repeated continental uplift has caused all the rivers to incise their meanders, in places to a depth of 1,000 feet and in the Great Kei valley (see Plate 100) to nearly 1,800 feet. As will be seen later these features exert an important influence on irrigation developments and on communications.

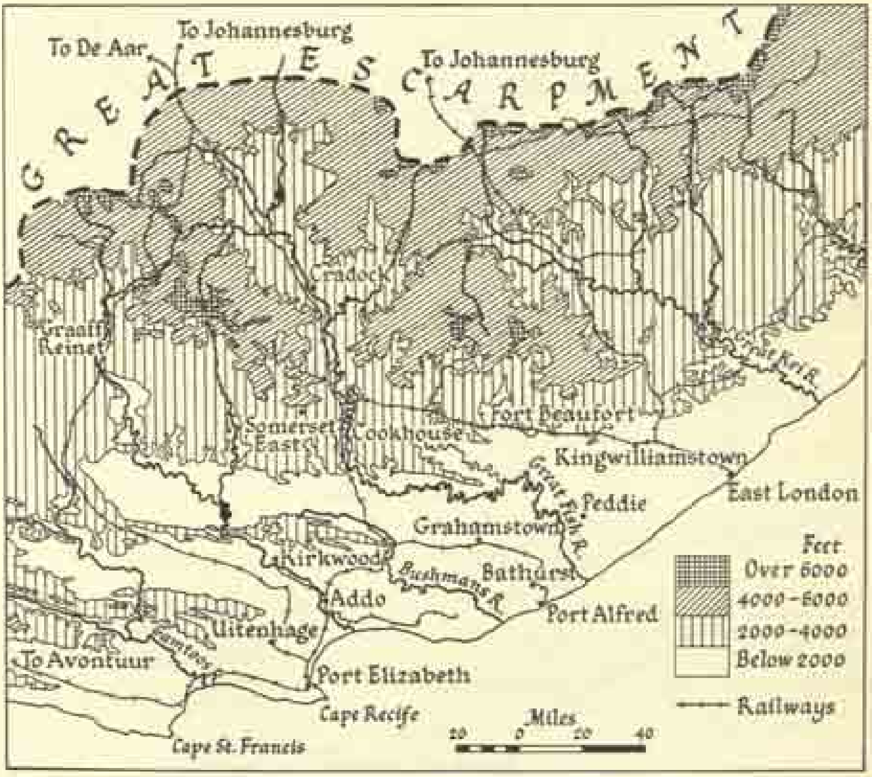


Fig. 194. The South-Eastern Cape; topography.

Climatically the region is transitional from the all-season rainfall belt of the southern Cape to the summer rainfall area of the east and from the humid equable coastal strip to the arid Karoo. The rainfall is lower and less reliable than in the neighbouring coastal regions, for, due partly to deflection by the Cape ranges, most of the winter depressions pass to the south of the Karreedouw mountains, and in summer the region is at the southern limit of the area influenced by moist air from the Indian ocean. Between Port Elizabeth and East London the total fall averages only 20 to 30 inches whereas to the west and north-east it exceeds 30 inches and is usually above 40 inches. Inland the amount varies

with the relief and distance from the sea and sharp differences occur within short distances (Fig. 197). Thus the rainfall decreases to less than 15 inches near Addo in the Sundays river valley, rises to more than 30 inches on the Suurberg to the north and decreases again to less than 15 inches in a broad stretch of country extending from Grahamstown westwards and north-westwards to the Sneeuwbergen. In the deeply cut valleys of the Sundays, Bushmans, and Great Fish rivers the total fall is even less, while on the other hand the Great Winterberg and

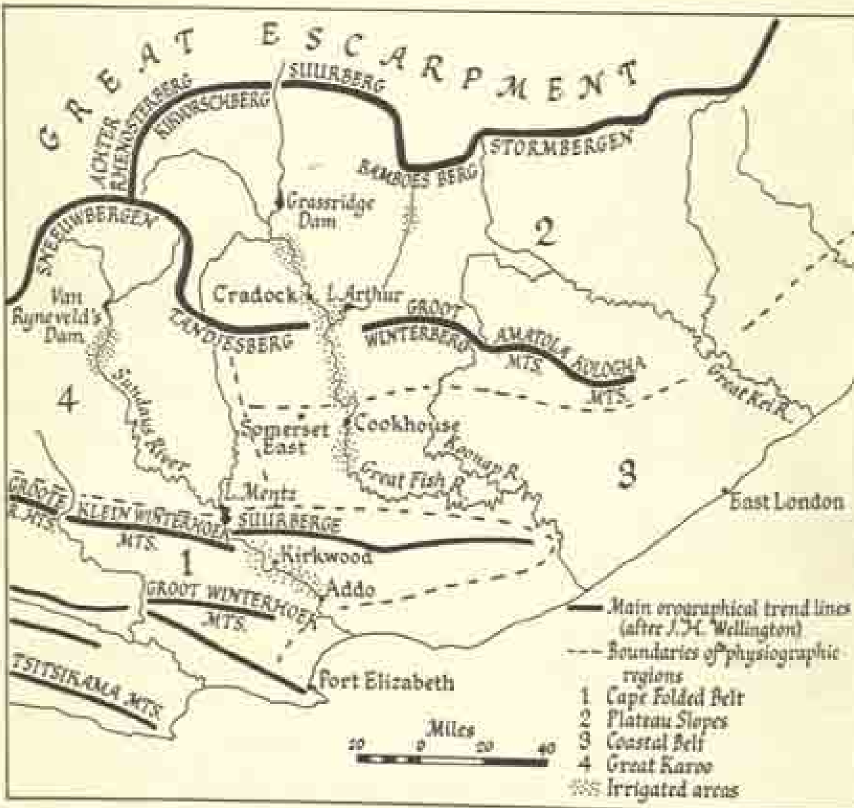


Fig. 195. The South-Eastern Cape; physiographic regions and main orographic lines.

(After J. H. Wellington.)

Amatola mountains enjoy more than 30 inches and towards the east, where not shadowed by the coastal ranges, as much as 60 inches. Here, too, heavy mists are frequent. Generally speaking the rainy period becomes shorter and the rainfall less reliable towards the interior.

The rainfall is fairly evenly distributed throughout the year; the maxima occur in autumn and spring, tending to be later in inland situations (Fig. 196).

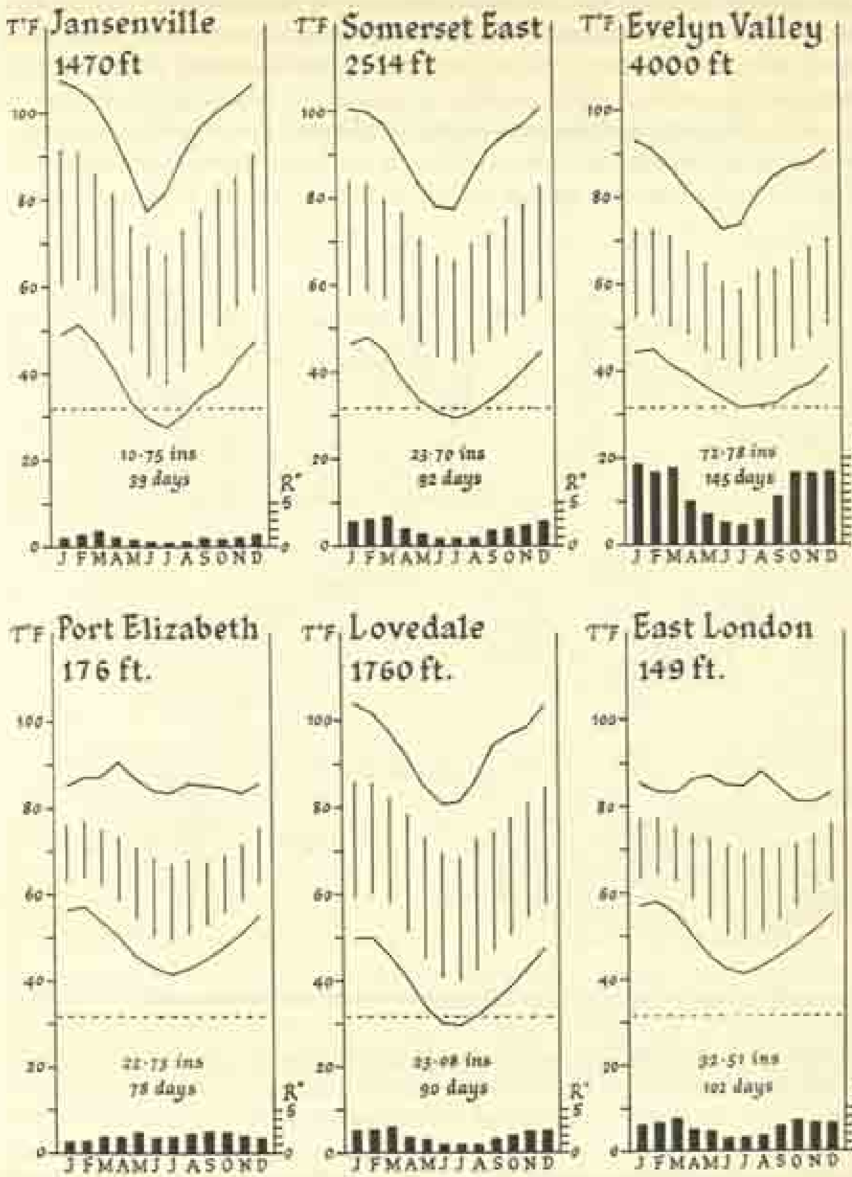


Fig. 196. Cartograms of the mean monthly rainfall and temperature at selected stations in the South-Eastern Cape.

Mean daily maximum and minimum temperatures are given by the upper and lower ends respectively of the vertical lines; the continuous lines above and below represent the mean monthly maxima and minima.

The summer rains are not usually associated with thunderstorms and are less intense than elsewhere. From time to time continuous rains on the watersheds cause the rivers to come down in flood, but sudden torrential downpours are rare.

The differences in altitude and exposure are likewise accompanied by marked differences of temperature (Fig. 196). Near the coast seasonal variations are slight; the winter maxima average 70° F., the minima around 50° F.; in summer

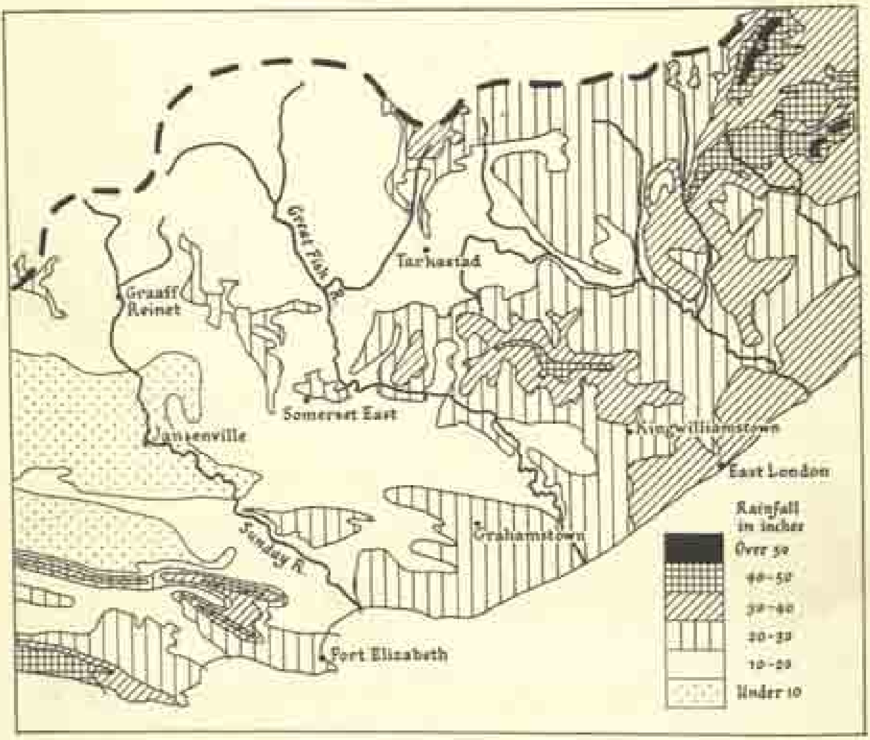


Fig. 197. The South-Eastern Cape; distribution of mean annual rainfall in inches.

it is some 5° F. warmer; frost and intense heat are unknown. On the higher ranges it is generally some 10° F. cooler both in summer and winter; on sloping ground frost is rare. The valleys and inland basins provide a sharp contrast; here the summer days are very hot with maxima averaging more than 85° F. and exceeding 100° F. on a number of occasions each year, while the temperature falls by about 30° F. at night; the winter days resemble those on the coast but at night the temperature falls below 40° F. and frosts are frequent. Near the coast the equable temperatures and evenly distributed rainfall are favourable to plant growth throughout the year but strong winds – East London with a mean velocity of 14 m.p.h. is the windiest place on the South African coast – particularly from the

south-east are a limiting factor. In the interior only those plants specially adapted to withstand the aridity, excessively high temperatures, and frost are able to survive.

Differing climatic conditions and a diversity of rocks have together produced a variety of soils. Over the quartzite ranges only thin, leached, sandy soils occur;

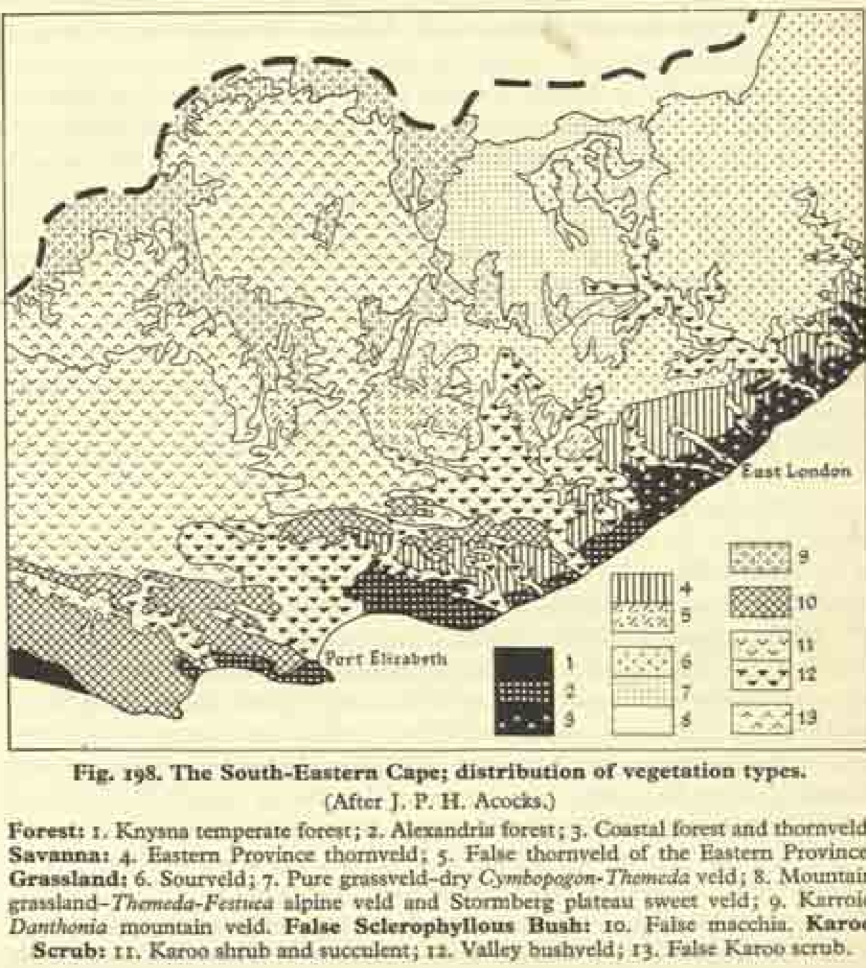


Fig. 198. The South-Eastern Cape; distribution of vegetation types.
(After J. P. H. Acocks.)

Forest: 1. Knysna temperate forest; 2. Alexandria forest; 3. Coastal forest and thornveld. **Savanna:** 4. Eastern Province thornveld; 5. False thornveld of the Eastern Province. **Grassland:** 6. Sourveld; 7. Pure grassveld-dry *Cymbopogon-Themeda* veld; 8. Mountain grassland-*Themeda-Festuca* alpine veld and Stormberg plateau sweet veld; 9. Karroid *Danthonia* mountain veld. **False Sclerophyllous Bush:** 10. False macchia. **Karoo Scrub:** 11. Karoo shrub and succulent; 12. Valley bushveld; 13. False Karoo scrub.

but reddish brown clays overlie the Bokkeveld shale and Dwyka tillite. The Ecca shales and sandstones are overlain by thin loams, which in areas of low rainfall show evidence of lime accretion. Near the coast the Cretaceous and Tertiary calcareous sandstones have weathered to a spongy calcareous tufa frequently covered with reddish clays, while along the main valleys patches of alluvium produce the most fertile soils of the region.

The transitional nature of the region is again evident in the vegetation which comprises a mosaic of grassland, macchia, forest and scrub (Fig. 198) – the product of the varied climatic and soil conditions in what is the zone of contact of the Cape and Tropical floras.

Near the coast strong winds preclude tree growth. Here the sand dunes carry a scrub which is composed mainly of succulents and forms a dense mat only a few feet high. Inland the undulating country between the major river valleys is covered with sour grassland[2] – hence the name Suurveld – while the deep valleys contain communities of drought-resistant shrubs and succulents from both the Tropical and the Cape floras, including both large forms such as *Euphorbia* spp. and *Aloe* spp. and dwarf shrublets (see Plate 28). Towards the interior with decreasing rainfall the sour grassveld gives way to sweet rooigras veld which, however, is much invaded by scrub pioneers, especially *Acacia Karoo*; on the lower slopes of the mountains this veld gradually passes to scrub and this in turn to dry forest. On the wetter southward facing mountain slopes, however, especially those of the Amatolas,[3] the scrub passes into macchia, dominated by *Cliffortia* spp., and this in turn to moist forest, composed of a wide variety of trees – yellow-woods, wild olives, *Cunonia* spp. – in an undergrowth of shrubs and ferns, where the rainfall exceeds 35 inches. Above 4,000 feet, however, and on exposed plateaux and ridges, the forest gives way to macchia dominated by *Erica* spp., alternating with patches of grassland, composed of species of *Danthonia*, *Festuca*, and *Themeda*. Between the Groot Winterberg and Amatola mountains and the Great Escarpment the vegetation is mainly grassland, but in the upper valley of the Sundays river it consists of Karoo shrubs and succulents, much invaded by introduced species of prickly pear (*Opuntia* spp.).

In the sphere of human settlement and race relations the south-eastern Cape is again a meeting place and zone of transition. It was the first well-watered region reached by the vanguard of Trek Boers as they spread eastwards across the southern Cape. Here they paused and settled. Here they encountered the southward advancing Bantu and here they were joined by settlers of English and German descent. For a time the problems of the 'Border' united the European peoples in their dislike of Cape Town rule but eventually the Boers trekked northward to the high plateau. The influence of the early settlement is still evident in the distribution of races and the language today (Fig. 199). Thus west of a zone hinging on the Sundays river both Europeans and Coloureds outnumber Africans; to the east the reverse is true;[4] to the west Afrikaans is the spoken language among the Europeans; to the east it is English and around Kingwilliamstown German too. And above all with increasing rainfall towards the east the region is transitional from one of sparse population to one of close settlement.

These influences are reflected in the economy and regional consciousness of the area. In the west the land is owned by Europeans, towards the Kei river Bantu reserves and European farms interlock.

The region is essentially an agricultural one, in which extensive pastoral

activities meet mixed farming operations and highly specialized fruit production. Merino sheep and English cattle breeds, notably Shorthorns, were first introduced here and today play an important part in the agricultural economy. This, however, being influenced by physical and economic factors varies considerably within the region.

In the country lying west of the Tandjesberg and Groot Bruintjes Hoogte and north of the Groot River Heights the karroid bush affords grazing suitable

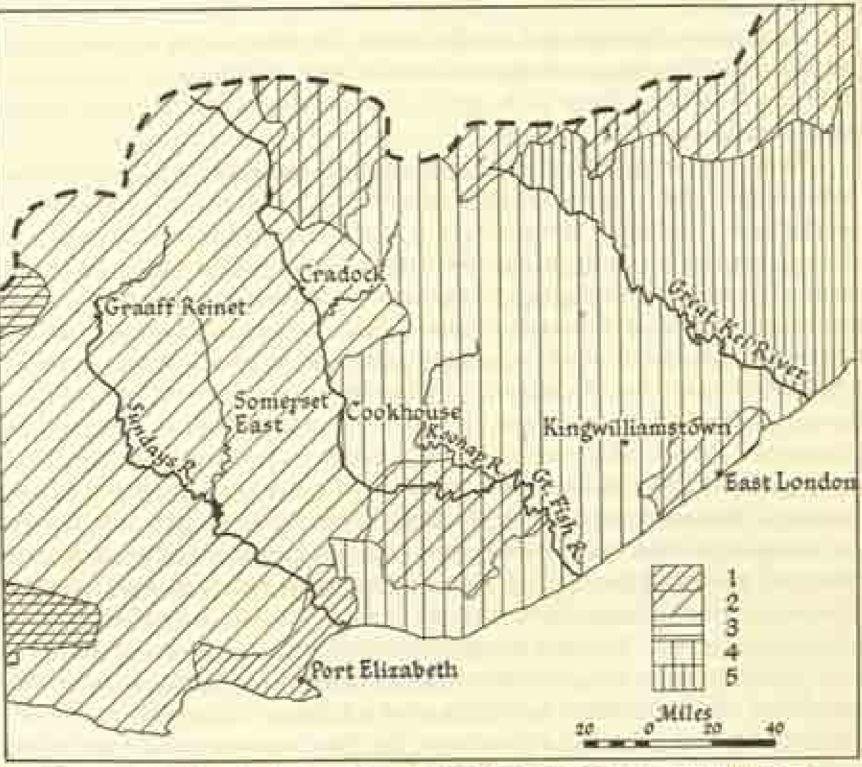


Fig. 199. The South-Eastern Cape; distribution of races and languages.
(After J. V. L. Rennie.)

1. Europeans make up over 40 per cent of total population. 2. Europeans make up over 25 per cent of total population. 3. Coloureds make up over 75 per cent of Non-European population. 4. Africans make up over 75 per cent of Non-European population. 5. Africans make up over 90 per cent of Non-European population.

only for sheep and goats and the aridity precludes crops unless irrigation can be practised; the farms are generally extensive. Formerly large numbers of angora goats were reared but poor overseas markets for mohair have caused the numbers to dwindle. Today merino sheep are the main concern; smaller numbers of goats and non-woolled sheep are also kept.

Between the Great Escarpment and the Groot Winterberg - Amatola mountains merino sheep are again the centre of agricultural activities, but the higher rainfall supports grassveld suitable for cattle, and makes possible the successful cultivation of wheat and oats in winter and of maize and lucerne in summer as well as the establishment of artificial permanent pastures. The cereals are grown for fodder purposes, the summers being too cool for ripening maize and the springs too wet for wheat. Farm operations revolve around the livestock industries which make this area one of the most important in the Union for wool, beef, and hides.

Plantations of wattles and conifers clothe the lower slopes of the Amatola mountains but the grassy stretches are used for stock. To the south cattle become more important than sheep as the grasses become longer. Teff is grown for hay and maize for fodder.

Prior to the expansion of wool production the lands between the Great Fish and Kei rivers were devoted mainly to cattle rearing. Grassveld was plentiful. Merino wool production brought wealth to the farmers but with it came also overgrazing and selective grazing and marked changes in the vegetation. In the sweetveld areas overstocking destroyed the more valuable grasses and encouraged the spread of the less palatable karoo shrubs, especially the 'bitter karoo', *Chrysocoma tenuifolia*, which is actually poisonous to stock. On the sourveld, grassland has given way to *Cliffortia* scrub on the lower slopes and to macchia on the upper slopes of the mountains. In both cases grassland is subclimax and the changes are normal successional ones which can be prevented only by heavy grazing followed by a period of rest. For this cattle and a paddocking system are necessary. Elsewhere overgrazing has thrown back the succession and favoured the spread of the Amatola weed, *Helichrysum argyrophyllum*, or destroyed the grass cover and permitted the entry of *Acacia karoo*, particularly near Fort Beaufort. The most serious changes have occurred in the Amatolas, particularly on land utilized by Natives. Originally the Natives settled in this area were given lots of from 10 to 40 acres each but subsequently many others came in to swell a population which expanded rapidly by natural increase. Today the reserves are over-populated and the land over-grazed. The Natives carry on their traditional economy, centred around cattle raising, for which purpose they are permitted access to lands belonging to the Department of Forestry for grazing. Here much of the land is steeply sloping and although the macchia and scrub are capable of conversion to grassveld it is felt that this would initiate erosion unless grazing could be controlled, which is unlikely at present.

The coastal belt is a zone of mixed and highly specialized farming. The suurveld affords grazing for cattle, which with ready markets for fluid milk in Port Elizabeth and East London are kept mainly for dairy purposes. Supplementary feed is necessary and hence maize and hay crops are grown and artificial permanent pastures established. Cattle farming is sometimes combined with pineapple production, which now takes up more than 12,000 acres; the early

producing areas were in Bathurst and Albany but recently good overseas markets and the establishment of a canning factory at East London have led to plantings both in the district of the same name and in Peddie. The fruit is grown on the level coastal plateaux where there is little danger of erosion, an essential pre-requisite since clean cultivation is practised. Only areas of grassveld have been cleared for pineapples for they do not succeed on land previously in heavy bush owing to the high humus content. Once established, however, they require liberal fertilization, particularly with rock phosphate. The usual life of a pinery is 10 to 15 years, after which the land is cover-cropped with sunnhemp, velvet beans, or more recently *Glycine javanica* and grazed by cattle for several years before being replanted. In this way small pineries are easily combined with cattle farming.

Perhaps more than any other region in South Africa the south-eastern Cape has suffered from recurrent disastrous droughts which have occasioned heavy stock losses. In the past the dangers have been greatly increased by overstocking. During the past two decades there has been a marked reduction in the sheep flocks and a swing back to cattle farming on European farms in the easterly areas. On Native farms overstocking remains a problem, the more serious since the number of cattle is inadequate for the population. The likelihood of drought makes some provision for water storage essential but as yet the only important works are in the valleys of the Sundays and Great Fish rivers. Here highly specialized types of farming are carried on and give rise to ribbons of intensive land use and close settlement cutting through the arid bush-covered country.

The opportunities for growing lucerne under flood irrigation along the valleys of the Sundays and Great Fish rivers fostered the development of ostrich farming (see Plate 52) during the early part of the century. For a time the valleys were prosperous, but the collapse of the feather market during the first world war brought distress; this was relieved only by the construction of large storage reservoirs which by assuring a perennial supply of irrigation water and protection from floods, made possible the production of citrus and deciduous fruits.

Today fertile alluvial soils in the Sundays river valley about Graaff-Reinet and between Kirkwood and Addo are respectively supplied with irrigation water from Van Rynevelds Pass dam and from Lake Mentz. In the former area cereals, lucerne, and deciduous fruits are produced, while the latter has become one of the most important citrus fruit producing areas in the country; the supply of irrigation water, however, is sufficient only for about 5,000 acres of perennial crops and most of the remaining 18,000 acres of irrigable land is devoted to lucerne. This supports a thriving dairying industry which sends fresh milk to Port Elizabeth and milk for processing to factories there and in Kirkwood. The abundance of orange blossom, lucerne flowers, and the wild spekboom have encouraged bee keeping and honey forms an important export while poultry keeping is carried on in the lower valley. The alluvial soils of the Great Fish valley are likewise irrigated from water stored in Grassridge dam and Lake

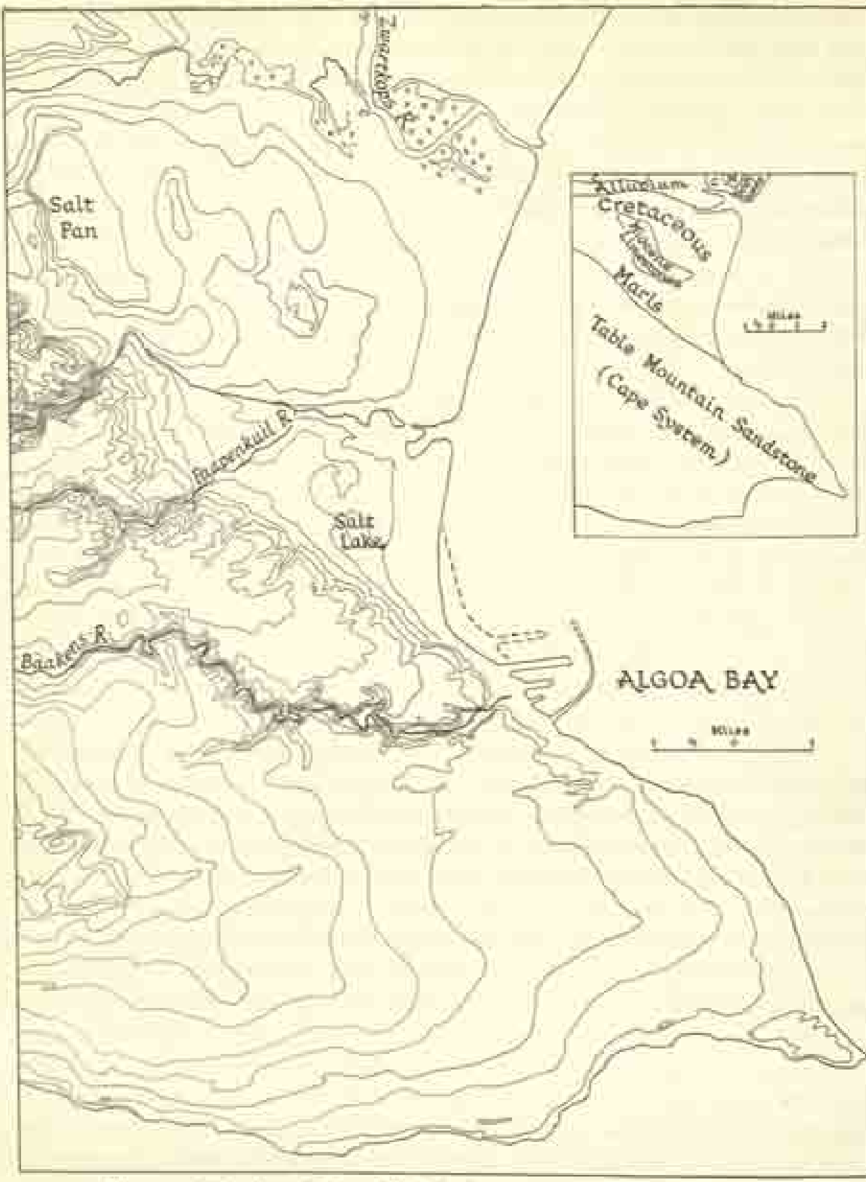


Fig. 200. The site of Port Elizabeth; geology, relief and drainage.

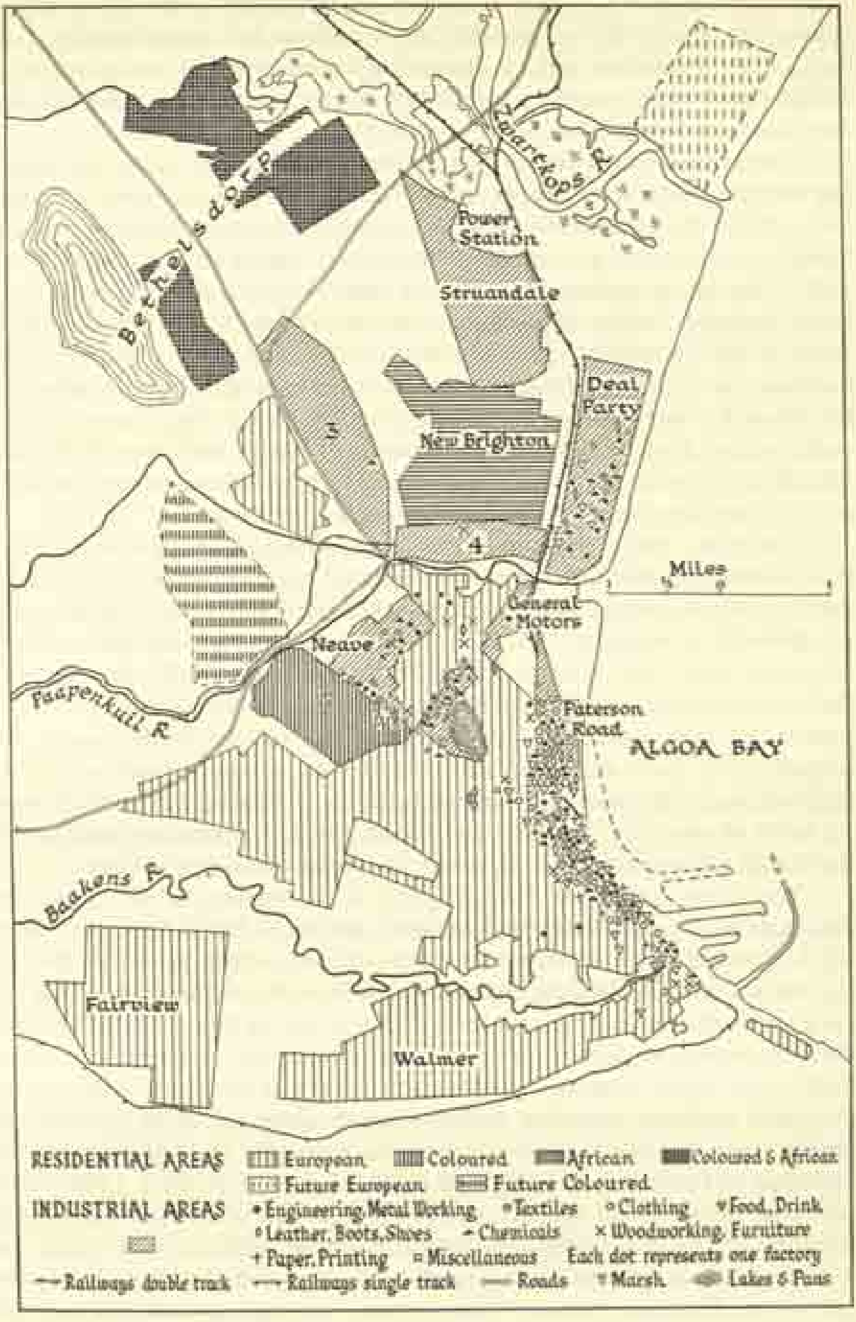


Fig. 201. Port Elizabeth; urban land use.

Arthur; in the early days deciduous fruits, especially apples and apricots, were grown but siltation of the reservoirs has so reduced the storage that the trees have had to be taken out and less demanding lucerne grown in their stead. Much of the future development of both valleys hinges on the project for bringing water from the Orange river (see ch. 7, p. 146).

The extensive stock raising areas are dependent on these valleys for lucerne hay and the valleys in turn focus on Port Elizabeth and East London for export and supplies. Both ports exert a unifying influence over the region. Between East London and Durban there are no good harbours while overland travel is made difficult by the succession of hill and vale occasioned by the deep gorges carved by the eastward flowing rivers. There is no railway link. West of Port Elizabeth travel is likewise difficult by reason of the fold mountains. Thus the region extending from the Great Escarpment to the coast between the 24th meridian and the Great Kei river focuses on the two ports. It has developed some regional consciousness made stronger by the presence of Native territories to the east. This finds expression particularly in the Cape Midlands Development Association and the Cape Eastern Bodies Association, which cover the area.

The greater part of the trade of Port Elizabeth and East London is with their near hinterlands from which wool and fruits are exported and to which manufactured articles are sent. Both, however, command routes to the interior which are followed by railways; both, therefore, serve the Free State and southern Transvaal, while Port Elizabeth is traditionally the port for the Rhodesian traffic. Both have developed industries associated with the preparation of the agricultural produce of their hinterlands – fruit canning, jam making, confectionery, the preparation of hides and skins, and manufacture of leather goods while Port Elizabeth assembles motor-cars. Around each the population has grown to meet the needs of expanding industries and port activities, whereas elsewhere, save in the coastal belt and the irrigated valleys, the population spread is sparse.

The urban pattern of Port Elizabeth is the product of the interacting influences of physical features and economic and social factors. The site chosen for the port and initial settlement was where the ridge of high ground formed by the Table Mountain Sandstone reached the coast on the northern side and at the point where the Baakens river broke through it to the sea (Fig. 200 and Plate 84). The first settlement climbed the high ground immediately west of the anchorage. Relief very largely dictated the subsequent growth of the town, with areas of European residence spreading north-westwards along the ridge between the Baakens and Paapenkuil rivers and factories occupying the low-lying ground underlain by Cretaceous rocks between the Salt Lake and the coast. Later Neave industrial township was laid out on the flat land west of the Salt Lake and a township for Coloured people on the rising ground adjacent to it. Since the second world war the town has expanded rapidly beyond the area bounded by the two rivers. European residents have favoured the high ground south of the Baakens river where Walmer and Fairview have grown up, while large areas of

flat land north of the Paapenkuil river have been acquired by the municipality and laid out in industrial estates with New Brighton, built to house the African factory workers, centrally located between them. A further residential area for both Coloured and African people lies farther north-west. Thus, the geological and topographical divide is also an economic and social one, with the wealthier Europeans occupying the attractive high ground of the Table Mountain Sandstone in the south and the poorer Non-Europeans sharing with industry the less desirable flat land produced by the Cretaceous rocks to the north.

Industrially Port Elizabeth is still comparatively young, but nevertheless some industries show a marked concentration in certain industrial areas. Thus the long-established industry of boot and shoe manufacture is concentrated in the old industrial area near the city centre. Here, too, are most of the clothing factories, the furniture makers, and the food and drink factories. By contrast the newer industries, particularly the textile works and chemical plants, occupy the newer industrial estate of Deal Party while the motor-car assembly plants have their own extensive sites.

Because Port Elizabeth is industrially young and because the influx of African workers is recent, the town has been able to plan its urban growth. By so doing it has avoided many of the problems of Johannesburg and stands as an example of co-ordinated development with all workers enjoying reasonable living conditions within easy reach of their work.

BIBLIOGRAPHY

1. J. H. WELLINGTON. 'The economic development of the Eastern Cape Province'. *S.A.G.J.*, Vol. II, 1928.
2. R. A. DYER. *The Vegetation of the Divisions of Albany and Bathurst*. Bot. Surv. of S.A., Mem. 17, 1951.
3. R. STORY. *A Botanical Survey of the Keiskammahoek District*. Bot. Surv. of S.A., Mem. 27, 1952.
4. J. V. L. RENNIE. 'The Eastern Province as a geographical region'. *S.A.G.J.*, Vol. XXVII, 1945.

38

The Eastern Plateau Slopes

The belt of dissected and varied country constituting the Eastern Plateau Slopes has come into being with the progressive recession of the Great Escarpment (see ch. 1, pp. 22–4) which forms its western boundary. In origin and surface form it contrasts sharply with the Highveld plateau to the west and with the Mozambique plain of marine deposition lying to the east. In the south it extends to the coast but north of St Lucia the Lebombo range and the Mozambique plain lie between it and the sea. The Soutpansberg closes the belt on the north while the southern limit is taken along the Groot Winterberg and the Amatola mountains. Genetically the upper drainage basin of the Great Fish river belongs to this region, but on climatic and economic grounds it is preferable to include it in the transition zone of the south-eastern Cape.

While having a common mode of origin, however, the Eastern Plateau Slopes range from over 4,000 feet down to sea-level and exhibit a variety of surface form. This is because they have been sculptured during several erosion cycles over varying geological structures (Figs. 202 and 203). As each erosion cycle has penetrated inland, it has destroyed the work of its predecessors. The rate of advance and destruction, however, has varied from one part of the region to another, and today surfaces belonging to the four erosion cycles recognized in southern Africa[1] are present (see Plates 99 and 100). In the south the Cape ranges have slowed up the processes. Here remnants of the oldest surfaces remain. By contrast north of the Umtamvuna river the monoclinal flexuring along the Lebombo axis (see ch. 1, p.12) gave added vigour to the African and subsequent cycles thereby hastening the destruction of their predecessors which becomes more complete northwards. In the south the Groot Winterberg and Amatola mountains represent the former edge of the Great Escarpment.[2] They enclose the Unga plain, an erosion surface lying between 4,000 and 5,000 feet which is attributed to the Gondwana cycle; northwards the floor of the Ladysmith basin (Fig. 203), which is some 1,000 feet lower, is of the same phase; still further north the Gondwana surface has been completely destroyed by subsequent erosion cycles. Surfaces attributable to the African cycle are widespread throughout the southern part of the region, forming in particular the benchlands

94. Panoramic view from the Klein Drakenstein mountains westwards across the Great Berg valley, showing the Klein Drakenstein mountains (left foreground) the Simonsberg (behind) and the Paarl Berg (right background).

95. Sand-dunes on the Cape Flats. These have been stabilized by the planting of marram grass (*Psamma arenaria*) (near the fence) and pypgrass (*Ehrharta gigantea*) (on the right), followed by Australian acacias, notably Port Jackson willow (*A. saligna*) (on the left), and golden wattle (*A. pyncantha*).

96. Vegetable lands on the Cape Flats. The wind-breaks of Port Jackson willow dividing the lands into narrow strips are to prevent the loose sandy 'soil' from blowing. The last of a cucurbit crop is visible in the foreground. With heavy fertilization and careful rotation high yields of vegetables and wheat are obtained on these strips.

97. The homestead and farm buildings of a dairy farm on the Cape Flats. Note the pump, turned by the strong winds which blow across the Flats, for obtaining bore-hole water.

98. Friesian cows on a dairy farm on the Cape Flats. The eucalyptus trees have been planted to provide shade.

99. Multi-cycle relief. Level surfaces belonging to King's African (the higher) and Victoria Falls cycles of erosion flanking the Great Kei river valley at Kei Bridge. The road descends to the Great Kei gorge more than 1,000 feet below. (See Plate 100.)

100. The gorge of the Great Kei river at Kei Bridge. The river is flowing eastwards from right to left across the photograph. The northern valley-side (left foreground) shows evidence of two riverine cycles of erosion prior to the present one. The valley floor is covered with valley bushveld (a Karroid type of vegetation). Aloe spp. characterize the slopes.

101. The Valley of a Thousand Hills. In the foreground the softly sloping country fashioned over Old Granite shows evidence, in its accordant summit levels, of a former peneplain (King's African surface), which is being dissected by the Umgeni river and its tributaries in a new cycle of erosion. In the distance the level summits capped with Table Mountain Sandstone may represent the remnants of a Gondwana surface. Everywhere the kloofs carry forest while the hills are in grassland.

102. The Eastern Plateau Slopes near Nottingham Road. The gently undulating Middleberg plateau in the foreground is developed over shales of the Beaufort Series and the Molteno and Red Beds of the Stormberg Series. The hills in the background are of Cave Sandstone. Behind is the Great Escarpment built of Stormberg lavas, with Cathkin Peak at its northern end (right). The Middleberg plateau is used for grazing and for hay and fodder crops. Teff hay is seen drying.

103. A typical scene in the tall grassveld of East Griqualand where about 75 per cent of the land is left in natural grazing and the remainder is used for fodder crops and established pastures. Cattle rearing is the main concern with the emphasis on dairying.

104. The Drakensberg grazing region. Cattle sent up to the summer pasturage on the slopes below the Great Escarpment near Cathkin Peak.

105. Tors and outcrops of bare rock showing exfoliation in the Old Granite country of the Transvaal Lowveld, between White River and Nelspruit.

106. The landscape in the eastern Lowveld near Pretorius Kop, Kruger National Park. An isolated inselberg rises from the relatively level surface; a kudu cow dominates the foreground.

107. The Lebombo Flats, underlain by Karoo sediments and lavas, with the Lebombo range built of Karoo basalt and rhyolite rising in the background. The major rivers trench the Lebombo range in narrow poorts, being unrelated to the present surface features and probably superimposed from a Karoo cover. Few crops are grown on the fertile soils of the Lebombo Flats but the savanna vegetation affords sweet grazing of low carrying capacity.

108. The Sabie river in the Transvaal Lowveld. Hippopotami occupy the permanent pools in the sluggish rivers of the tropical regions of the Transvaal and Natal.

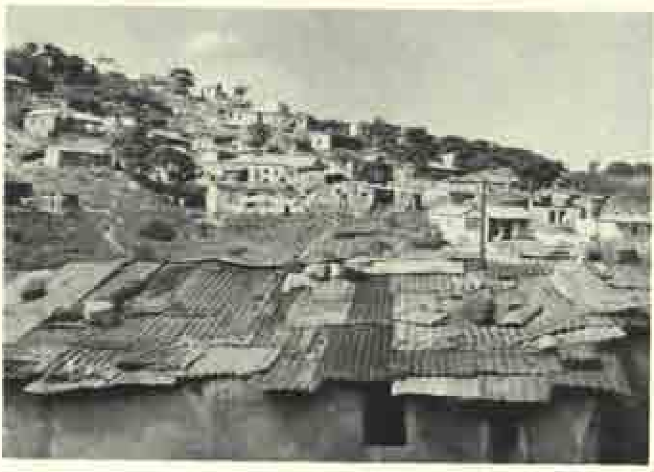
109. The Eastern Transvaal Lowveld. View southwards down the White river valley from near *Plaston*. The river occurs at the line of contact between cleared land and bush on the extreme right. The heavy soils near the river are used for vegetables. Citrus groves occupy the better drained loams above.

110. Cotton lands in the southern part of the Barberton Basin. The crop has just been picked. In the background is the Barberton Mountain Land.

111. The 'Gates' at Port St Johns where the Umzimvubu river has cut a gorge through a horst of Table Mountain Sandstone in order to reach the sea. Note the heavily wooded slopes below the bare sandstone Krantzes.

112. The Natal coast at Port Shepstone, showing in the foreground the sand bar which blocks the exit of the Umzimkulu river to the sea and through which the river maintains a channel only with difficulty during the summer months.

113. Durban: the Back Beach. Note the mixture of old and new buildings, the modern tendency being to 'spread' upwards. In the background is the Bluff.



114. Slum conditions in Cato Manor, Durban, where Indian and Bantu live in close proximity to one another.

115. The Vaal river above Vereeniging where it is flowing over Karoo rocks in a broad open valley.

116. Typical view of farmland on the Transvaal Highveld, showing the arable lands under maize, which is everywhere the main crop, and the characteristic belts of eucalyptus trees which are planted to provide shelter and shade as well as fuel.

117. Typical scene on a Highveld farm in the Standerton area where dairying or beef production is combined with maize growing and concrete silos for winter feedstuffs are characteristic among the farm buildings. Note the tractor, replacing the trek-oxen of the pre-war period.

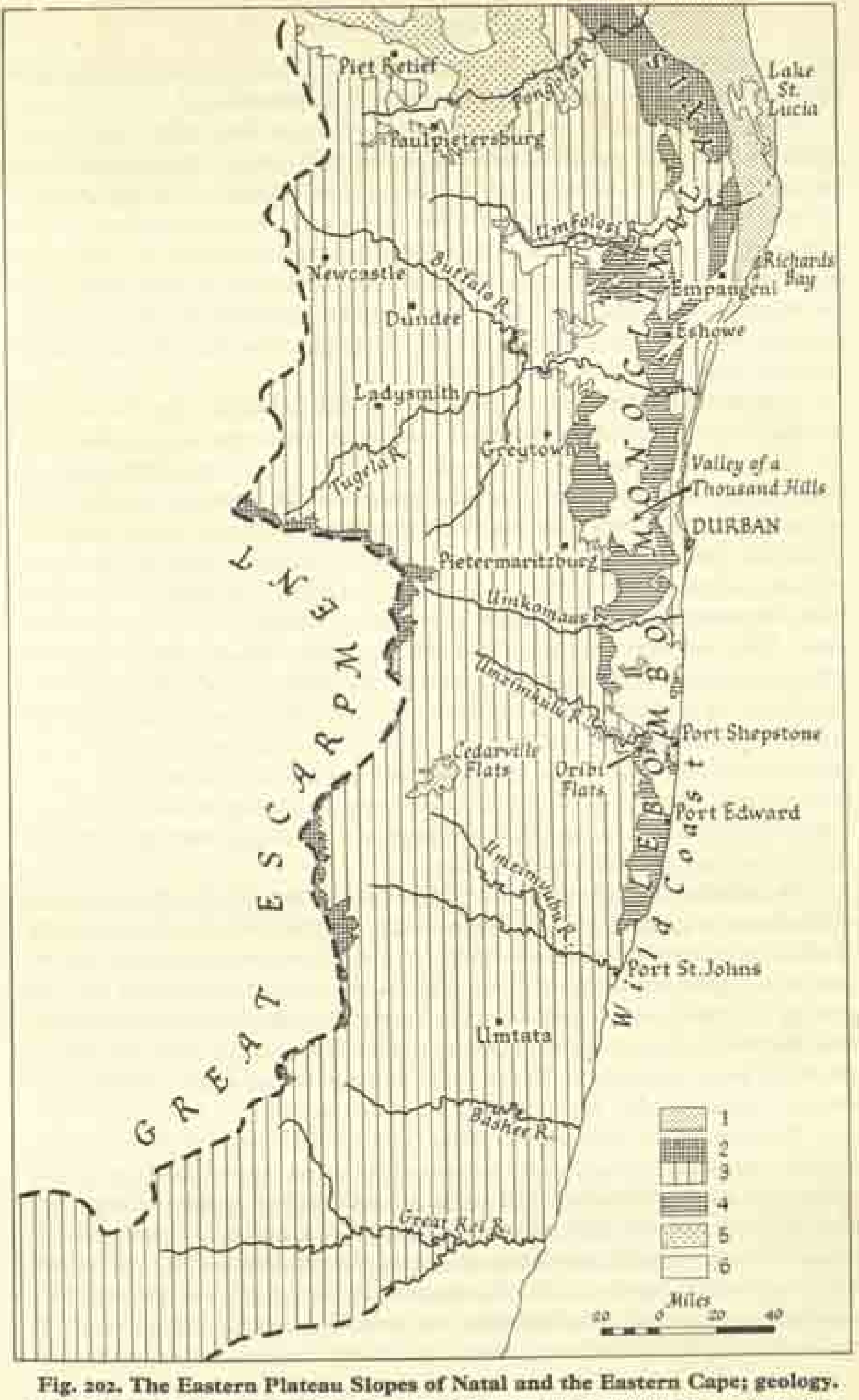


Fig. 202. The Eastern Plateau Slopes of Natal and the Eastern Cape; geology.

1. Sedimentary rocks, unconsolidated sands of Cretaceous to Recent age. 2. Stormberg basalts and rhyolites of the Karoo System. 3. Sedimentary rocks and tillite of the Karoo System (Dwyka, Ecca and Beaufort Series). 4. Table Mountain Sandstone of the Cape System. 5. Quartzites, lavas, etc., of the Witwatersrand and Dominion Reef Systems (Pre-Cambrian). 6. Old Granite and more ancient Archaean rocks.

of the Natal Midlands, but in the Swaziland and Transvaal Lowveld they were consumed during the course of the Victoria Falls planation.

The present surface features are the expression of both stage – in this case cyclic surface – and underlying geology. In the south erosion during four cycles has uncovered rocks varying in age from Karoo to Old Granite (see Fig. 202) and in type from shales and sandstones to lavas and granites and has produced a complex of plateaux and basins, hills and valleys, and coastal lowland. By contrast in the Transvaal and Swaziland Lowveld, erosion during the Victoria Falls cycle has destroyed the surfaces of earlier cycles, has stripped away the younger rocks (see Fig. 206) and in fashioning the Old Granite has produced an inselberge studded landscape (Plates 105 and 106).

The drainage pattern is relatively simple, with numerous short trunk rivers flowing to the Indian ocean. Near their sources the rivers are actively eating into the Great Escarpment and occupy narrow valleys. Their middle courses are characterized by sluggish stretches over the erosion surfaces and waterfalls and gorges where they pass from one erosion surface to the one below (Plate 5). Where the junction between two erosion surfaces coincides with the outcrop of resistant dolerite, the waterfalls may be 300 feet high, e.g. Howick falls, Qunu falls. The lower reaches of the rivers show marked contrasts. In Zululand coastal dunes force the rivers to parallel the coast for some distance before they can achieve an outlet to the sea and lagoons are a common feature. By contrast in Natal and the Cape the rivers enter the sea through confined valleys cut into Karoo sediments and in Pondoland the Umzimvubu river has trenched a narrow gorge through resistant Table Mountain Sandstone in order to reach the sea at Port St Johns (Plate 111). Of the east coast rivers the Tugela has the most extensive catchment basin, having taken advantage of a major west–east trending fault and cut back and effected several captures.

The weather and hence indirectly the climate is controlled by the interaction of air masses originating over the Indian ocean and the continental interior. The maritime air masses are responsible for the weather experienced during the greater part of the year but continental air masses may become established for long periods in winter, particularly over the Transvaal Lowveld which is separated from the sea by the Lebombo mountains and the Mozambique plain. In summer the warm moist air from the Indian ocean provides the conditions conducive to summer thunderstorms which bring most of the rainfall. The continental air is dry. Near the Great Escarpment, particularly in Natal and the Eastern Cape, however, periodic frontal activity between differing air masses produces a little instability rain at all seasons. The region generally enjoys warmer winters than the Highveld and, the Lowveld excepted, receives a higher and more reliable rainfall. Owing to its distance from the sea and the persistence of the continental air mass in winter, however, climatic contrasts distinguish the low country of the eastern Transvaal and Swaziland from the diversified country further south. In the former less than 30 inches of rainfall is normally received and the winters are

characteristically dry; the summers are hot with mean temperatures between 70° and 80° F. and the winters warm with means between 60° and 70° F. The daily range of temperature is great; excessively high temperature may be experienced but frost is rare. Southwards the coastal belt generally receives more than 40 inches of rainfall distributed throughout the year but with a summer maximum; inland the amount varies from over 50 inches on exposed slopes to less than 30 inches in enclosed river valleys, and is concentrated in summer. The coastal belt is warm and equable, with mean monthly temperatures between 60° and 75° F. and little diurnal range. By contrast inland the winters are markedly colder with minima as low as 35° F. and frequent frost in places. The seasonal and diurnal variations of temperature are greater than along the coast and extremes are experienced in the enclosed valleys and basins. On the uplands the summers are cooler than elsewhere in the region. Thus climatically the Lowveld, the coastal belt, and the uplands and valleys are distinct.

The greater part of the Eastern Plateau Slopes is covered with tall grassland, here and there replaced by temperate evergreen forest where moisture and temperature conditions are favourable. In the north, however, where the rainfall is below 30 inches the grassland gives way to sub-tropical evergreen and deciduous thorn forest and in the coastal belt of Natal and the eastern Cape is replaced by evergreen and deciduous bush and sub-tropical forest.

Within the region varied climatic conditions leading to the operation of differing soil-forming processes, and the exposure of diverse rocks to yield parent material, are responsible for a variety of soils. In the warmer wetter areas to the north lateritic soils predominate; farther south podsolic soils cover the area from the Escarpment to the coast; where the rainfall is low and sporadic as in the eastern Transvaal and Swaziland and in the Tugela basin unleached sub-tropical soils prevail.

From this brief consideration of their physical geography it is clear that the Eastern Plateau Slopes comprise three natural units, namely:

(*a*) the Uplands of the Transkei, Natal, and western Swaziland
(*b*) the Lowveld of the eastern Transvaal and eastern Swaziland
(*c*) the coastal lowland of Natal and the Transkei

each possessing somewhat different opportunities for economic development. Each will be considered in turn.

The Uplands of the Transkei, Natal, and Western Swaziland

The greater part of this sub-region is underlain by rocks of the Karoo system. These have a slight westerly dip so that the progressively younger rocks of the Dwyka, Ecca, Beaufort, and Stormberg Series outcrop in turn in a westerly direction with the resistant lavas of the last mentioned forming the great wall of the Drakensberg along the Natal–Basutoland border (Fig. 202). North of the Umtamvuna river, however, older rocks, notably the Table Mountain Sandstone and the Old Granite have been exposed along the southerly continuation of the

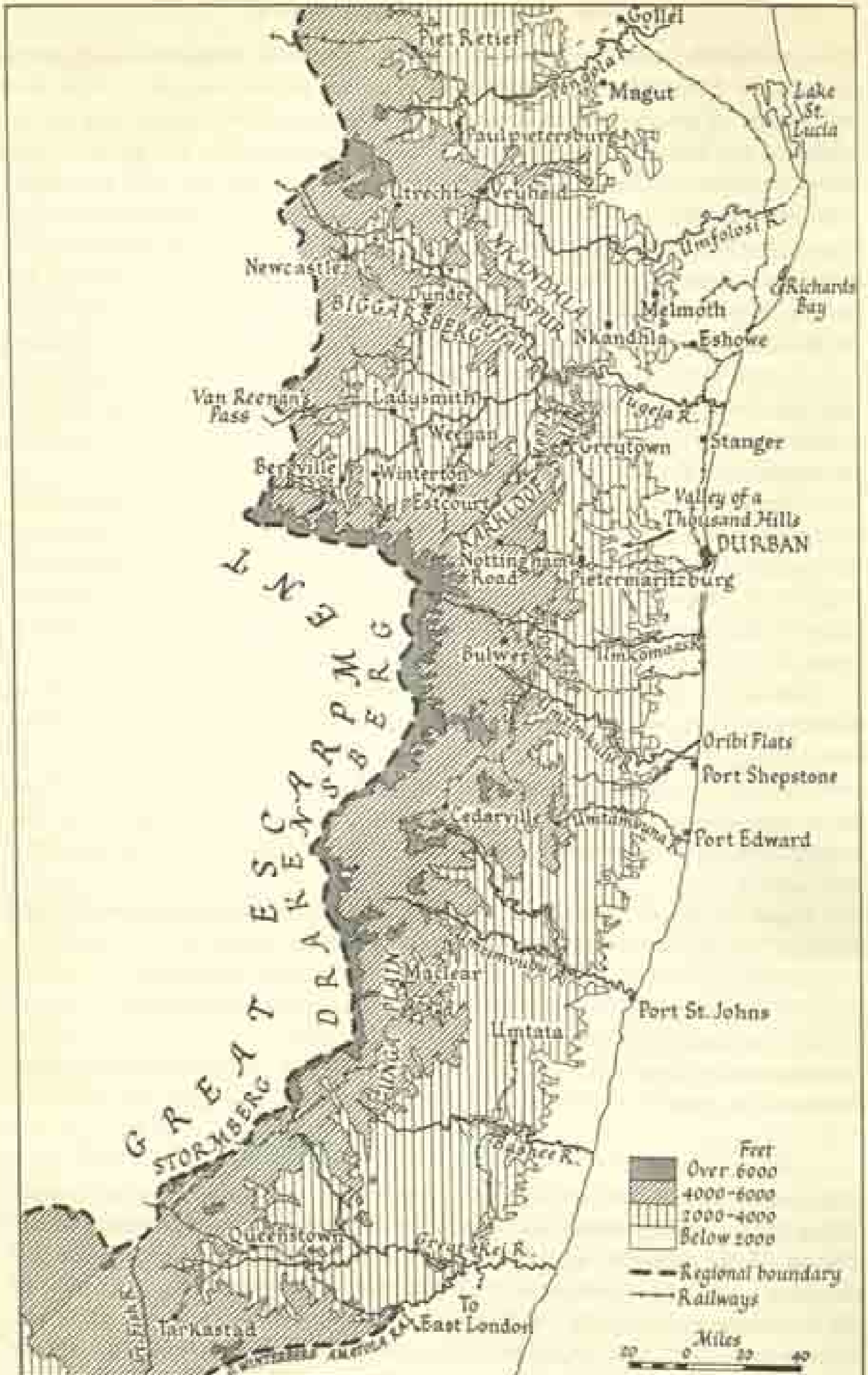


Fig. 203. The Eastern Plateau Slopes of Natal and the Eastern Cape; topography.

Lebombo monocline. Strikingly contrasting surface features distinguish the areas underlain by Karoo and pre-Karoo rocks.

Extensive level surfaces separated one from another by abrupt slopes provide the outstanding relief features of the area underlain by Karoo rocks. Generally attributed to the work of successive erosion cycles (see ch. 1, pp. 14–21) their formation has been favoured by the character and disposition of the underlying rocks, notably the nearly horizontal alternating sandstones and shales of the Ecca series and the widespread sheets of resistant dolerite. The most widely developed surfaces are the intermediate one at between 2,000 and 3,000 feet which embraces the Natal Midlands, and farther inland, an older one at between 3,000 and 5,000 feet comprising a number of detached basins, e.g. the Unga plain and the Ladysmith basin. The former was planed during the African cycle and the latter before the break-up of Gondwanaland. Neither are continuous but are broken up on the one hand by prominent spurs over 4,000 feet, e.g. the Umsinga and Kranskop spurs (Fig. 203), and on the other by deeply entrenched transverse valleys, particularly that of the Tugela river. The spurs represent unconsumed portions of the Highveld surface protected by a capping of resistant rock, usually dolerite or Cave Sandstone, during the retreat of the Great Escarpment. The entrenched valleys are the advance guard of post-African erosion cycles.

The axis of the southerly continuation of the Lebombo monocline has been the scene of concentrated erosive activity which has removed the Karoo rocks and exposed the Table Mountain Sandstone and Old Granite. Here the present surface features are the product of this erosion on rocks of differing type. Thus under the influence of high rainfall and vigorous stream dissection the Old Granite has been sculptured into a complex of hills and valleys typically developed in the Valley of a Thousand Hills (Plate 101) midway between Pietermaritzburg and Durban. By contrast the Table Mountain Sandstone forms towering flat-topped plateaux or mesas through which the rivers have cut deep trenches. The best known of the sandstone blocks are the Murchison and Oribi 'flats' through which the Umzimkulwana tributary of the Umzimkulu river has cut a magnificent gorge behind Port Shepstone. The axis of the monocline is considered to mark the zone of transition where the African and Gondwana surfaces converge; here the ridge tops surmounted by sandstone residuals are their sole remnants; the entrenched valleys mark the headward creep of the Pleistocene erosion cycle which is fashioning the coastal plain. Western Swaziland is another transition zone. Here the work of the African cycle has been obliterated and the Victoria Falls cycle, which is responsible for the present features of the Lowveld to the north, is impinging on the Gondwana surface. Where the Old Granite is exposed it has been dissected to gently hilly country but where the Witwatersrand and Primitive Systems outcrop their alternating quartzites (and other resistant rocks) and shales have given rise to well-marked ranges separated by deep valleys.

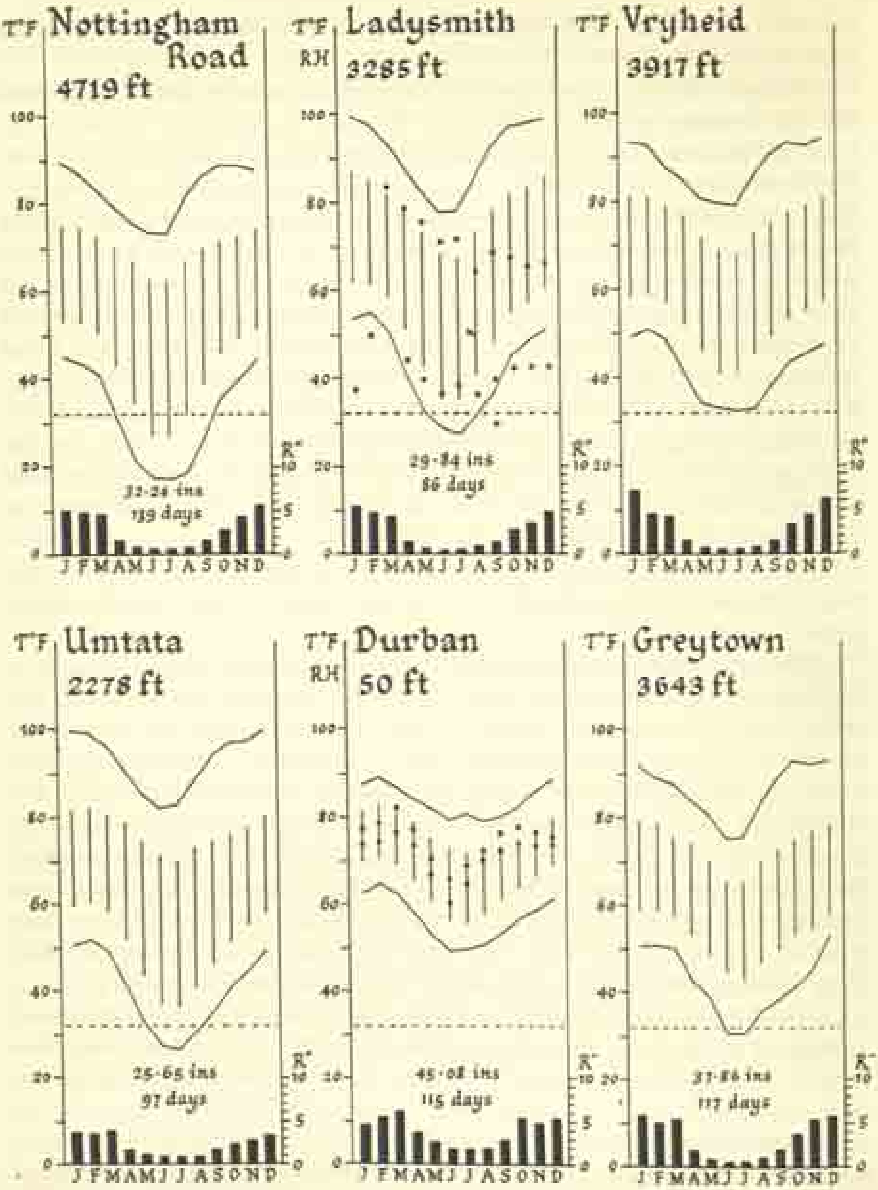


Fig. 204. Cartograms of the mean monthly rainfall, temperature and humidity at selected stations on the Eastern Uplands and in the Coastal Belt of Natal and the Eastern Cape.

Mean daily maximum and minimum temperatures are given by the upper and lower ends respectively of the vertical lines; the continuous lines above and below represent the mean monthly maxima and minima. The dots show the mean values of relative humidity at 0830 hours and 1500 hours (South African standard time).

Thus today the surface features comprise level basins and benches, plateau spurs and narrow gorges, rounded hills and open valleys, depending on the stage reached in the cycles of erosion and the nature of the underlying rocks. The more important of these features are shown in Fig. 203.

The diversity of relief introduces variations of climate (see Fig. 204). Both altitude and surface form influence the temperatures, particularly the minima. Thus the intermediate bench experiences hot summers, with daily maxima around 80° F. and nightly minima around 60° F., and warm winters with temperatures rising to between 65° and 70° F. during the day and rarely falling below 45° F. at night. The belt of hilly country on its inner margin experiences similar maxima but markedly lower minima with even some danger of frost in the valleys on winter nights. The interior basins and the deep transverse valleys suffer great extremes; in the Ladysmith basin the summer maxima average 85° F. but frequently exceed 90° or even 100° F., while the nightly minima are around 60° F.; in winter the days are often hot with temperatures rising to 70° F. by midday but the nights are cold (with minima averaging 35° F.), and frost is frequent. Contrasting sharply with the basins are the highland spurs, which are markedly cooler; here the summer maxima rarely exceed 75° F., the winter days are cool and the nights decidedly cold with frequent severe frost; at Nottingham Road, at an altitude of 4,000 feet in the Natal Midlands, for example, severe frost occurs on 60 per cent of the nights in July.

The rainfall distribution is much influenced by altitude and exposure; the rainfall associated with both the summer thunderstorms and the winter instability showers is increased by any displacement of the air mass so that the higher ground and the seaward facing slopes receive more than the interior basins and enclosed valleys. The greater part of the area receives between 30 and 40 inches annually but the amount falls below 30 inches in the Ladysmith basin and in the valleys of the Buffalo, Umfolosi, and Umzimvubu rivers while it increases to more than 50 inches on the high ground of the Natal midlands and again towards the Great Escarpment. Here the rainfall is supplemented by mist which usually forms at about 2,000 feet and becomes more persistent with increasing elevation.

Thus the intermediate bench is a warm moist region, the interior basins, due to their high summer maxima, are sub-humid, while the highland spurs are cool and wet. These differences are reflected in the type of vegetation and in the nature of the land use.

Grassland vegetation covers the greater part of the region but its composition and behaviour and thereby its value for grazing vary with the local climatic conditions. The intermediate bench and the lower mountain slopes receiving between 30 and 40 inches of rainfall are covered by tall grassveld, dominated by *Hyparrhenia* species, which grow rapidly during the summer when they afford highly nutritious grazing, but become fibrous and less palatable as the season advances. At higher levels where the rainfall is heavier and the winters longer the grasses, mostly shorter and denser, grow exceedingly rapidly during summer

when they are very nutritious,[3] but mature early and thereafter have little food value; where the slopes are steep and there is little danger of frost *Protea* spp. – mainly *Protea Abyssinica* – are scattered through this sour grassland. By contrast the dissected monoclinal area, the low-lying dry interior basins, and transverse valleys carry a vegetative cover of shorter grasses, mostly *Themedra triandra* (rooigrass) studded with thorn trees, generally *Acacia karoo*. These grasses are sweet and maintain their high feeding value even when dry and dormant and hence afford grazing the year through. Scattered throughout the area are the remnants of once more extensive temperate and warm temperate forests, the former in sheltered kloofs above 4,000 feet and the latter clothing the mountain slopes at lower elevations; at present the most extensive natural forests remain in the Nklandhla area and on the Karkloof spur.

Except in a few favoured areas agricultural development is handicapped by physical and/or economic factors. High altitude and low temperatures present difficulties only in the Drakensberg and on some of the higher land above 5,500 feet elsewhere, but inadequate and badly distributed rainfall, rugged terrain, and thin and stony soils impose much more serious limitations. Land sufficiently level or undulating for cultivation occurs only on the Midlands bench, the Karkloof spur and Mooi River Heights, and in the interior basins. In the last mentioned, however, the rainfall is less than 30 inches which, associated with high temperatures, produces sub-humid conditions; these areas are therefore marginal for crop production. Even where the total exceeds 30 inches a dry period of four months duration[4] hampers both crop production and pastoral activities. Moreover development is further hindered by poor communications. Only one trunk railway – from Durban to Johannesburg – crosses the region (see Fig. 203). Branch lines run to the eastern Transvaal, Free State, and East Griqualand; but only the Midlands bench has any semblance of a net. In the south branch lines from Umtata and Maclear connect with the Springfontein–East London line; but there is no through north to south connexion. Due largely to inaccessibility there are many areas being farmed in a manner ill-suited to the environment with the resulting evils of declining fertility and soil erosion.

Intensive farming is at present confined to the intermediate benchland[5] (Fig. 205), where level land occurs in an area of adequate rainfall and moderate temperatures and rail facilities provide access to the urban markets of Durban and Pietermaritzburg. In the surrounding area and also along the trunk railway farming is semi-intensive; elsewhere it is carried on only on an extensive scale.

Owing to the differing opportunities offered by physical and economic conditions the land use varies from one part of the region to another and a number of agricultural sub-regions may be recognized (Fig. 205).

The most favoured area is that known as the Natal Midlands which embraces the intermediate benchland and the escarpment backing it. It includes, in the mist belt north of the Umkomaas river, the main wattle-growing areas (see ch. 15, p. 261). Here much of the land is owned by large companies and used only for

wattle plantations. There are, however, a number of private farms which combine wattle bark production with other agricultural pursuits. These vary greatly in size[8] but an average farm comprises about 1,000 acres of which about 70 per cent is in grazing, 15 per cent is planted to wattles, and the rest used for crop production. On the smaller farms wattle plantations occupy a relatively smaller proportion of the land and crop production is more important. Usually about 200 head of cattle are kept both for dairying and beef stock fattening. Dairying is particularly important in the valleys below the mist belt where good rail and road facilities provide access to the urban markets of Pietermaritzburg and Durban, while stock raising replaces it in the less accessible areas. South of the Umkomaas river, due to lower altitude and absence of mist, conditions are less favourable for wattles. Here dairying is very important, particularly around Ixopo and Donnybrook, where an industrial milk factory takes the surplus not required by the Pietermaritzburg and Durban fluid milk trade. Potato production is locally important around Donnybrook and Underberg while beef stock fattening and maize production are carried on in the less accessible areas.

The northern foothill belt of Natal is essentially a zone of broken relief, poor soils, and severe winter cold. It is situated about midway between Durban and Johannesburg and although served by the main line railway and the branch line to Breyton, is distant from markets. It is primarily a pastoral region of large farms many of which belong to Highveld farmers who use them only during the winter months. Both cattle and sheep are kept, the former mainly for beef and the latter for meat and wool. Only a small percentage of the land is cultivated, mainly for maize, which is increasingly fed to stock. Locally, however, more intensive agriculture is practised. Thus between the Great Escarpment and the Vryheid basin and again around Paulpietersburg and Luneberg milder winters and rail connexions have encouraged the German settlers to practise dairying, pig rearing, and the production of wattle bark. Wattle plantations occur also near Gluckstadt and Entonjaneni where the conditions resemble those in the Midlands. On the higher parts of the Buffalo river basin about Glencoe and Dundee and near Newcastle and Utrecht, dairying, stimulated by the milk markets in the coalfields, is again important, while potatoes form the chief cash crop.

The Drakensberg foothills are used only for extensive pastoral farming. Above 5,000 feet the rigour of the winters and the fact that the sourveld pasture is palatable only for five months of the year restricts grazing to the summer months, when both dairy and beef cattle move up from the thornveld and the lower grassland areas. Much of the land, however, is mountainous and only the gentler shoulders are utilized.

The upper part of the Tugela basin is a region of tall-grassveld and fairly intensive mixed farming (see Plate 102), the lower part passes into thornveld country. In the upper basin dairying is the main activity and large quantities of milk are sent to factories at Estcourt, Winterton, and Bergville. Maize and fodder crops are grown while pigs are kept to utilize the whey and corn stalks, and feed

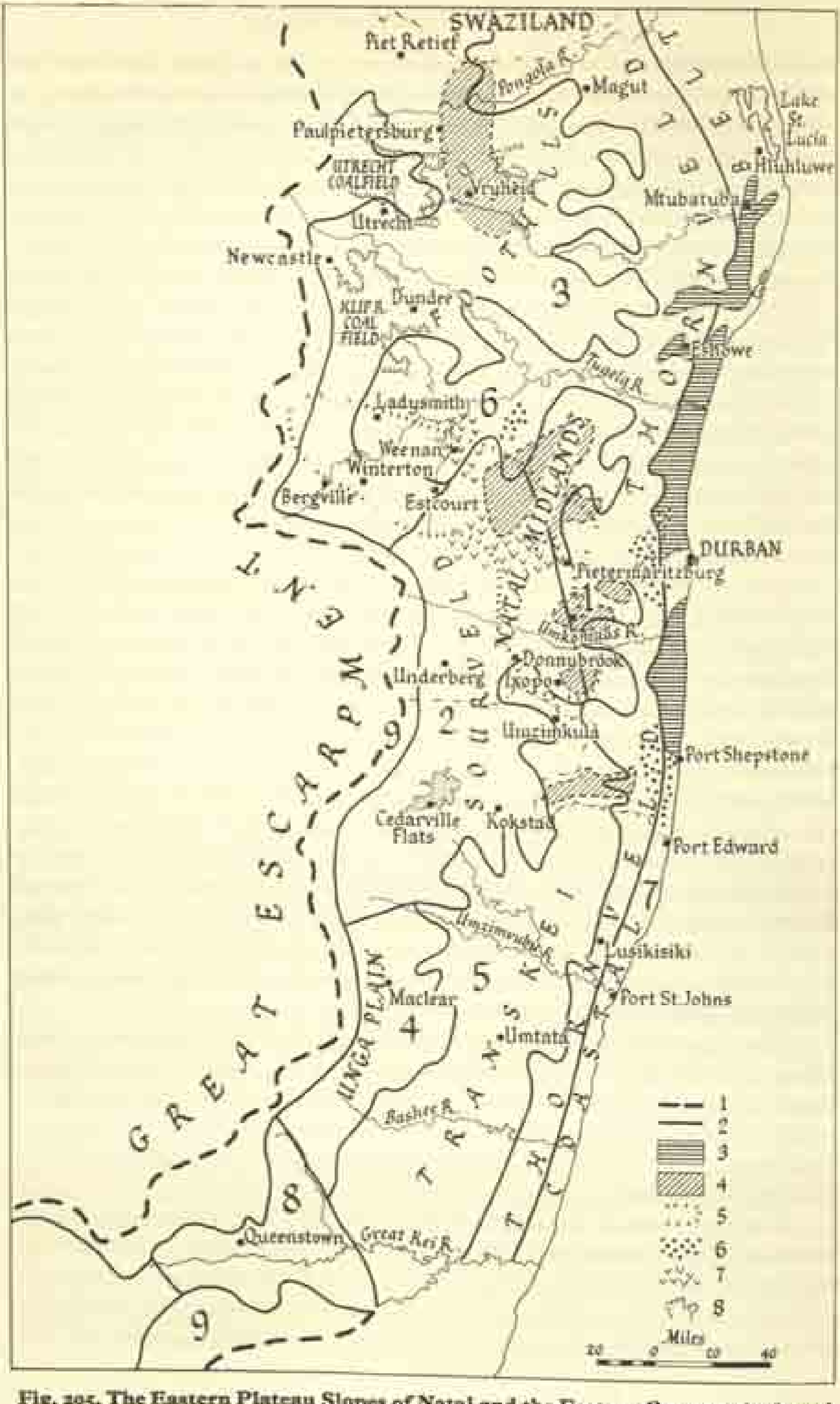


Fig. 205. The Eastern Plateau Slopes of Natal and the Eastern Cape; agricultural sub-regions and economic activities.

1. Regional boundary. *2.* Boundaries of agricultural sub-regions: 1. Natal Temperate

the bacon and sausage factories at Estcourt. On the larger farms beef cattle are also kept. Of recent years there has been a marked intensification of farming in this area concomitant with the establishment of the factories at Estcourt, a trend likely to continue.

East of Ladysmith the Tugela enters the thornveld country, where sweet grazing is available the year through; low rainfall and lack of communications make this cattle ranching country while large tracts are used as 'labour' farms – European-owned farms given over to Native occupation in order to ensure a supply of farm labour. Citrus fruit ,however, has long been grown under irrigation around Weenan and Muden, while high prices have encouraged cotton cultivation again near Magut. A good deal of the land is in native reserves, much of it highly dissected and hilly; here the kraals occupy the tops of the hills and are surrounded by bare ground, so kept to deter snakes; if there is room small patches are cultivated for maize, but more frequently the arable lands are relegated to the steep slopes below used mainly for cattle grazing. Everywhere in this land which carries a dense Native population, mainly of women and old people, severe soil erosion is evident.

The tall-grassveld of Natal is continued into East Griqualand (Plate 103) where, however, the more severe winters consequent on greater elevation and more southerly location preclude wattle plantations. The area is essentially one of stock farming. The farms are larger than elsewhere on the Eastern Plateau Slopes, most of them exceeding 2,000 acres. About 75 per cent of the land is left in grazing; the remainder is under crops – maize, wheat and other winter cereals, teff – grown almost entirely for fodder, and established pastures. Crop production is particularly important in the plain of deposition known as the Cedarville flats, where the fertile alluvial soils promote excellent yields. The stock carrying capacity of the farms is relatively high – about one unit to between 2 and 3 morgen. Dairying is the main activity and brings in the highest income; most of the milk is sent to creameries and cheese factories for the area is distant from Durban, but recently increasing quantities have been diverted to the fluid milk trade. Large numbers of good wool sheep are also kept on the larger farms. Other livestock enterprises are unimportant.

The Unga Plain is a transitional area. Proximity to the Stormberg range results in bitterly cold winters with occasional snowfall. Frost occurs from mid-April until September while untimely cold weather may be experienced in

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Area; 2. Sourveld of Natal and East Griqualand; 3. The Foothills; 4. The Unga Plain; 5. The Transkei; 6. The Thornveld; 7. The Coastal Belt; 8. Mixed Farming Area around Queenstown; 9. Drakensberg Grazing Areas. *3*. Sugar cane belt. *4*. Main wattle areas. *5*. Zone of intensive animal husbandry. *6*. Main fruit-growing areas. *7*. Mainvegetable-growing areas. *8*. Limits of the coalfields.

Numbers in Italics refer to the key.

(Agricultural sub-regions after the Division of Economics and Markets; areas of specialized farming partly after K. Buchanan and N. Hurwitz.)

October and November. The rainfall is somewhat lower than elsewhere but good falls in March make wheat cultivation possible. Level land favours arable farming which is more important here than elsewhere. The agricultural economy, however, is essentially a mixed one, the rearing of sheep and cattle being combined with the production of both fodder crops and cash grains. Wheat is the most important cereal; it is not of good quality and is often spoilt by spring rains but it fits well into the economy and provides spring grazing for lambing ewes; maize and oats are also grown along with roots and other fodder crops. Sheep are more important than cattle for they are better able to withstand the cold winters. The carrying capacity of the veld is lower than in East Griqualand but the farms are smaller. Farm incomes are generally low and this together with remoteness has led to rural depopulation in recent decades.

The rest of the Eastern Uplands lies in the native territories of the Transkei and Swaziland. Physically the Transkei is one of the most favoured areas for mixed farming in South Africa. It consists of gently rolling hills (see Plates 81 and 82), traversed by a number of great valleys. Lying between 1,000 and 3,000 feet above sea-level it is markedly lower than the rest of the region while its southerly location and proximity to the sea combine to produce a moderate climate. The rainfall comes mainly in summer, with the peak in March, but some is received in winter. Hence both summer and winter crops can be grown. Sedimentary rocks of Beaufort age outcrop over most of the area, but they are much intruded by dolerite which weathers into deep and fertile soils. The vegetation consists of tall grassland with Rhodes grass, *Digitaria* spp. and *Hyparrhenia* spp. as the climax grasses on the warmer slopes and rooigras (*Themeda trianda*) at higher levels and on cooler southerly slopes. Repeated veld burning in autumn has, however, thrown back the succession and the sweet grasses have been replaced by couch grass (*Cynodon* spp.) on the warmer slopes and *Eragrostis* spp. and *Sporobolus* spp. elsewhere. There are very few European farms in the Transkei. The native agricultural economy is based on woolled sheep with the keeping of pigs and growing of maize, kaffir corn, beans, and pumpkins for subsistence. Cattle are also kept but are less important than in other reserves. The area is very closely settled and innumerable trim mud huts replete with windows and thatched with reeds, dot the landscape. In front of each group of huts is the patch of arable land enclosed by a fence of aloes or sisal. Beyond are the grazing lands. Only a small proportion of the land is actually cultivated; the veld carries an average of one stock unit per 3½ acres. Overstocking without any provision of fodder crops, combined with veld burning, has caused a deterioration in the value of the grazing and initiated soil erosion, while continuous cropping of the same land, mainly for maize, has brought about declining fertility. The land suffers from over-population and a primitive economy. With a reduction in the population dependent on agriculture and the introduction of fodder crops and a crop rotation, it is capable of giving a good return from mixed farming. In order to achieve the first the establishment of industries has been advocated (see ch. 34, p. 524) but the Bantu

lack the necessary capital and technical resources and Europeans can build factories only in adjacent European areas. So far the Good Hope textile mill at Zwelitscha (see ch. 28, p. 440) stands alone.

The plateau slopes of eastern Swaziland are about equally divided between European and Swazi farms, but the Native population outnumbers the European by sixty to one. Thus while geographical conditions may encourage similar agricultural activities, the scale and emphasis must differ. In the west alternating quartzites and shales produce a broken relief of ridge and valley averaging between 4,000 and 6,000 feet elevation and clothed only with short grasses which provide excellent grazing in summer but are unpalatable in winter except after firing; eastwards where the granite comes to the surface the surface is rolling and of lower elevation – the Middleveld – and supports long grasses which retain their feeding value throughout the year. Steep slopes limit crop production and interest centres on stock rearing. In the west many of the European farms are used solely as winter grazing grounds by Highveld sheep farmers who burn the grass to induce young growth, thereby causing a deterioration in the veld. At lower altitudes the farms are in permanent occupation and both cattle and sheep are kept. Beef production is discouraged by the small internal market and the embargo imposed by the Union Government on cattle entering that country. Until 1937 dairying was possible only in the Hlatikulu-Goedegum area which alone was within easy reach of a railhead – at Piet Retief.[7] In that year, however, a butter factory was established in Bremersdorp[8] and has since encouraged a marked increase in dairying particularly among Natives in the neighbouring area. Extensive European-owned plantations of black wattle occupy the mist belt in the Mankaiana and Hlatikulu districts but the producers suffer the disadvantage of having to send the bark to Union factories while they do not qualify for the subsidy granted by the Union Government to the Transvaal and Natal producers.

By tradition the Natives are cattle keepers rather than cattle herders; they have continually increased their herds beyond the capacity of the veld with consequent deterioration in the quality of their stock and heavy losses from starvation. Since 1942, however, in an endeavour to remedy this evil and at the same time give the Natives a cash income the Swaziland Administration has organized cattle sales in the Native areas;[9] incentives to improvements in quality have been provided in the establishment of a native dairying industry in 1937 and the introduction of a hide and skin marketing scheme in 1946. In order to relieve the congestion on the land, in 1942 additional areas were set aside for Native settlement, particularly in the Piggs Peak and Herefords districts in the north. Here each settler receives at least 60 acres of which from 5 to 15 acres are arable and 45 acres or more are in communal pastures; measures have been introduced in order to control grazing and effect improvements in agricultural methods. But to resettle all the Natives on this basis would require 40 per cent more land than the total area of the territory.

Some alternative employment is provided by the Havelock asbestos mine

which developed rapidly during the war years and now ranks as the largest in the world with an annual output valued at nearly £1 million in recent years. This is situated in such isolated wild mountainous country that the product is got out by means of an overhead cableway to Barberton in the Union, but around it a sizeable settlement has already grown up.

The Eastern Uplands constitute an essentially agricultural region. Coking coal and iron ore are mined near Dundee and Vryheid, where there are coke ovens, and there is a blast furnace at Newcastle, but for a number of reasons a large-scale iron and steel industry has not developed (see ch. 25). Other industries are associated with agricultural produce. The processing of milk, pork, and bacon is carried on in Estcourt situated in the midst of a dairying and maize-producing area and on the main Johannesburg–Durban railway; extract factories deal with the wattle bark, sawmills process timber and an expanding boot and shoe industry utilizes the hides produced in the varied agricultural areas surrounding Pietermaritzburg. Near the Drakensberg the spectacular scenery and invigorating climate attract holiday makers and there is a flourishing tourist industry centred particularly near Mont-Aux-Sources, Cathedral Peak, Cathkin Peak, and Champagne Castle. The population density is high for South Africa, with Europeans clustered along the main railway line and Natives concentrated in the Trankskei and Zululand. Pietermaritzburg, situated in a basin-like area along the Mooi river, is the largest town with a total population of more than 73,000 in 1951; it is the focus of several agricultural areas and is a railway junction; it has grown rapidly during recent decades and with expanding industries promises to continue to do so. Estcourt is another developing town while Umtata is the centre for the Transkei and the seat of the Native Bunga Parliament.

The Lowveld

The greater part of the Lowveld[19] is underlain by the Old Granite but ancient metamorphic rocks of the Primitive System form the Barberton Mountain Land and the Murchison Range (Fig. 206). In the east the old rocks are covered with sediments and lavas of Karoo age but the Old Granite reaches the surface in the west where it has weathered to a maze of rounded hills here and there diversified by long narrow ridges where diabase dykes cut through it. Eastwards the surface is less dissected and inselberge of diminishing size rise from a relatively level plain (Plates 105 and 106). In the extreme east the complete cover of Karoo sediments gives rise to a featureless lowland which ends abruptly against the Lebombo range built of Karoo lavas (Plate 107).

The Lowveld is crossed by a number of trunk rivers whose courses are unrelated to the present relief or to the underlying geology. It is probable that they originated on Karoo beds which formerly covered the ancient rocks and that the present surface features have been fashioned by the forces of drainage superimposition as well as those of scarp recession.

Today, as in the past, erosive forces are dominant in fashioning the land-

scape. Near the Great Escarpment landslide erosion is common where percolating water causes the Old Granite to become kaolinized at depth so that it forms a slipway. Farther east lateral corrosion takes place above local base levels when the rivers are in flood. Away from the rivers mechanical weathering, conditioned by

Fig. 206. The Lowveld; geology.

the great diurnal variations of temperature, is dominant and outcrops of bare rock showing exfoliation and kopjes composed of huge perched boulders are common (Plate 105). There has been little opportunity for the formation of soils most of which are very thin. Alluvial deposits occur only upstream of the poorts

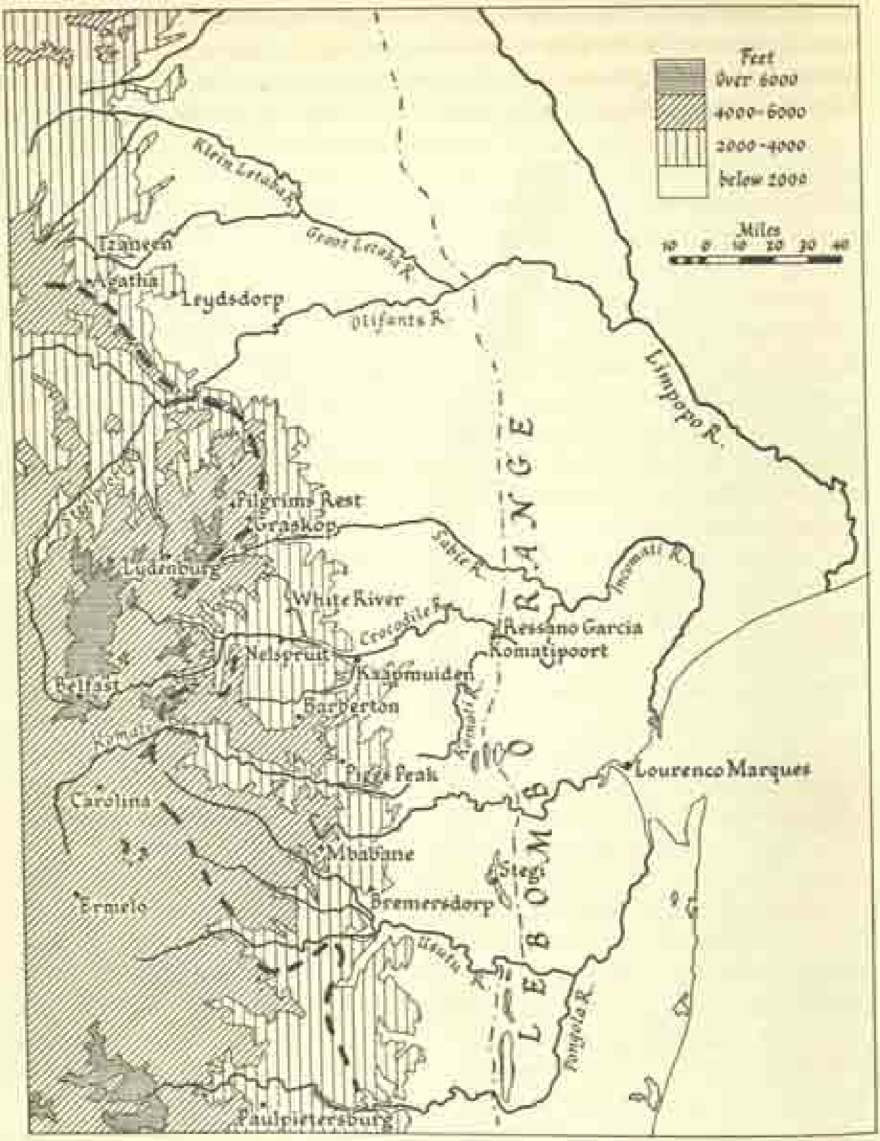

Fig. 207. The Lowveld; topography.

which mark the sites of former or existing local base levels where the rivers encountered resistant rocks during the process of superimposition.

The climate is one of warm dry winters and hot rainy summers. Generally speaking within the region the temperatures increase and the rainfall decreases as the altitude declines eastwards from the foot of the Escarpment towards the

Mozambique border (see Fig. 208). In winter the mean temperatures vary between 57° and 62° F. near the Escarpment; in the east they are about 6° F. higher. In summer they are around 70° F. in the west and 80° F. in the east. At both seasons the diurnal range of temperature is great, averaging about 20° F. near the Escarpment and 30° F. in the east. Exceptionally high temperatures, sometimes exceeding 105° F., may be experienced towards the end of the dry season when the daily range may exceed 50° F. and the relative humidity may drop from about 65 to 80 per cent, according to location and aspect, in the early morning to only 10 per cent by mid-afternoon. The rainfall increases from less than 20 inches in the north-east to over 60 inches along the Escarpment. It is concentrated in the summer months, occurring in the form of heavy downpours associated with thunderstorms. The winter months – June, July, and August – are practically rainless but near the Escarpment where the orographic displacement of the air mass produces some instability rain, light falls occur during the transition seasons. The total rainfall varies considerably from year to year, particularly in the east where deviations from the mean of up to 20 per cent must be expected in most years.

The soils over most of the area are of a lateritic nature. Generally sandy they absorb water readily but have a poor water retaining capacity. They are leached of their more soluble mineral salts and, where derived from granite parent rock, are exceptionally deficient in calcium, potash, and available phosphate; where there is some admixture of material from diabase dykes, however, they are better supplied with these constituents. In the drier eastern part of the area Brown Sandy Loams and Clay Loams (see ch. 4, p. 88) are found. These are only slightly leached and are well provided with calcium, magnesium, soda, and potash but like all Lowveld soils their humus content is low. The best soils are derived from alluvium which, however, covers only very limited areas along the major rivers.

Of all the essentially agricultural regions of South Africa the Lowveld has experienced the most spectacular development since 1939. The region actually first attracted Europeans during the late nineteenth century when the Murchison and de Kaap goldfields were worked and Barberton grew up as a small mining centre. Soon after the completion of the Pretoria–Lourenço Marques railway which follows the Crocodile river valley, suitable temperatures and opportunities for irrigation encouraged the growing of out-of-season vegetables around Kaapmuiden and the planting of citrus trees near Nelspruit. After the first world war a number of settlers took up land in the Elands, White, and Crocodile valleys where they grew vegetables and planted citrus and other sub-tropical fruit trees. Others tried cotton around Barberton. They encountered many difficulties, however, and owing to the prevalence of malaria, most vacated the area in mid-summer. During the second world war the development of effective measures for the control of malaria and other insect-borne diseases completely changed the picture while the enormous demand for vegetables for processing for military personnel

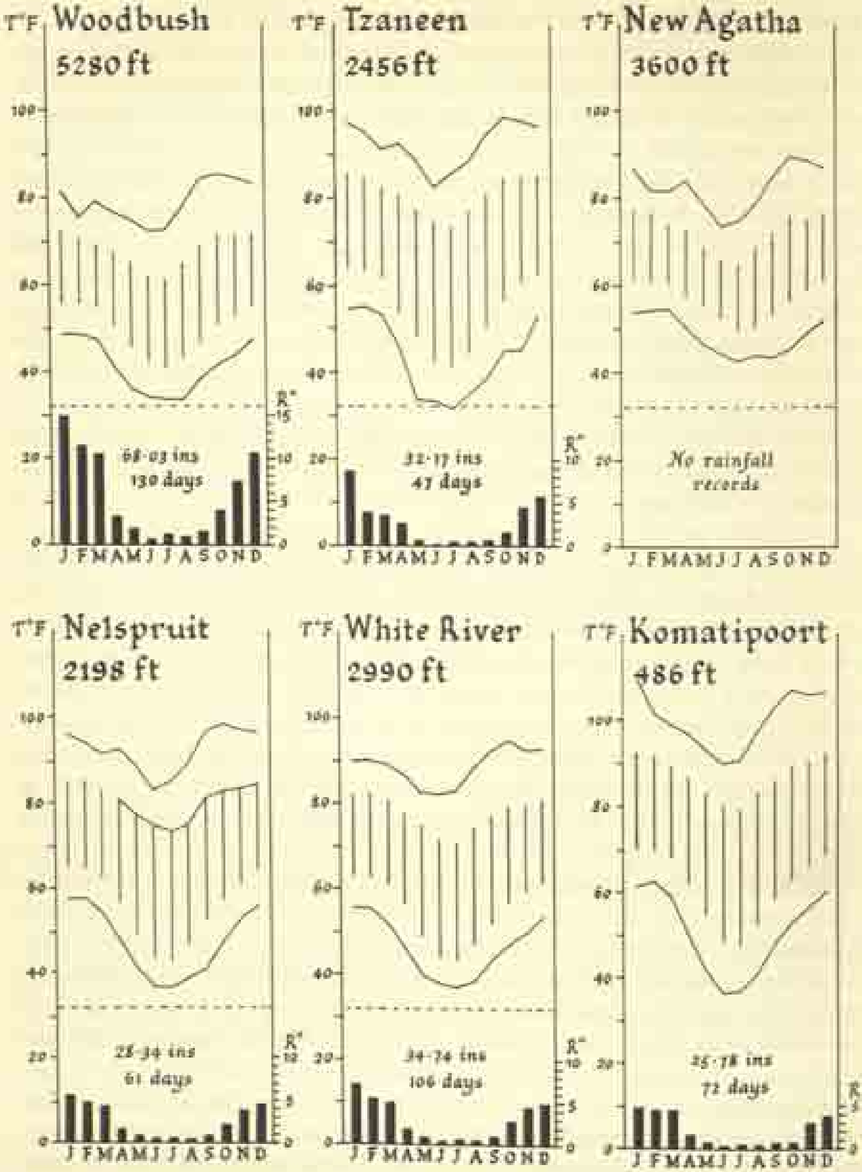

Fig. 208. Cartograms of mean monthly rainfall and temperature at selected stations in the Lowveld and on the Great Escarpment.

Mean daily maximum and minimum temperatures are given by the upper and lower ends respectively of the vertical lines; the continuous lines above and below represent the mean monthly maxima and minima.

encouraged bush clearing on a large scale. Since the war with many new settlers entering the area the Lowveld has developed very rapidly.

Owing to the nature and seasonal incidence of the rainfall, intensive agriculture is dependent on irrigation. At present it is largely restricted to the valley of the Crocodile river and its tributaries and to the area around Tzaneen and Ofcolaco where the headstreams of the Groot Letaba are used. Interest centres on the production of sub-tropical fruits and winter vegetables. A little irrigation is practised along the Komati river and in the south the Pongola river is used for sugar cane production. A small dam – Longmere dam – has been constructed across the White river but elsewhere the irrigation canals are either led directly from the tributary streams or fed by water pumped from the main rivers. Away from the irrigable valleys drought-resistant crops can be grown where there is adequate level land but elsewhere stock rearing is the only possibility.

An enormous variety of sub-tropical fruits, out-of-season vegetables and flowers, and field crops are grown in the Lowveld. Citrus fruits and especially oranges are, however, of outstanding importance. They are grown mainly along the Crocodile and White river valleys west of Krokodilpoort. East of Krokodilpoort and in the Tzaneen and Ofcolaco the higher temperatures are more favourable for mangos and papaws, large quantities of which are grown. Recently large plantings of litchi trees have been made near Nelspruit and Tzaneen. In the cooler more humid areas, avocados, guavas, granadillas, and bananas are successfully grown but the tung-nut trees planted in the upper valleys of the White and Elands rivers when Chinese supplies of tung oil were cut off have proved generally disappointing. Vegetable production is concentrated along the Crocodile valley east of Krokodilpoort, where settlement is recent, the winters are exceptionally mild, and rail facilities enable growers to reach the markets of all the large towns. Other important producing areas surround the processing factories at Rivulets and Politsi. Tomatoes are the main concern, followed by cucurbits and green beans in the warmer areas while cabbages and peas are produced in the higher valleys where light frosts are experienced.

Where transport facilities are limited or irrigation impracticable field crops are grown. Most important is cotton (see ch. 11, pp. 192–3) grown mainly in the Barberton basin (Plate 110). 'Stokroos' (see ch. 11, p. 193) is grown in the upper valleys of the Sand and Elands rivers, snuff tobacco is important on diabasic loams near Barberton and White River and on the alluvial soils along the Kaap, Elands, and Lomati rivers. Groundnuts and sweet potatoes are widely grown on the lighter sandy soils, maize almost everywhere. Wheat, barley, and oats are grown under irrigation as winter crops in the cooler valleys near the Escarpment, mainly for cattle feed.

In the more remote areas cattle ranching is the sole concern. The natural bush affords grazing of low carrying capacity but as Napier Fodder, Nile Grass, the Setarias, and Paspalums yield large quantities of hay and silage when grown

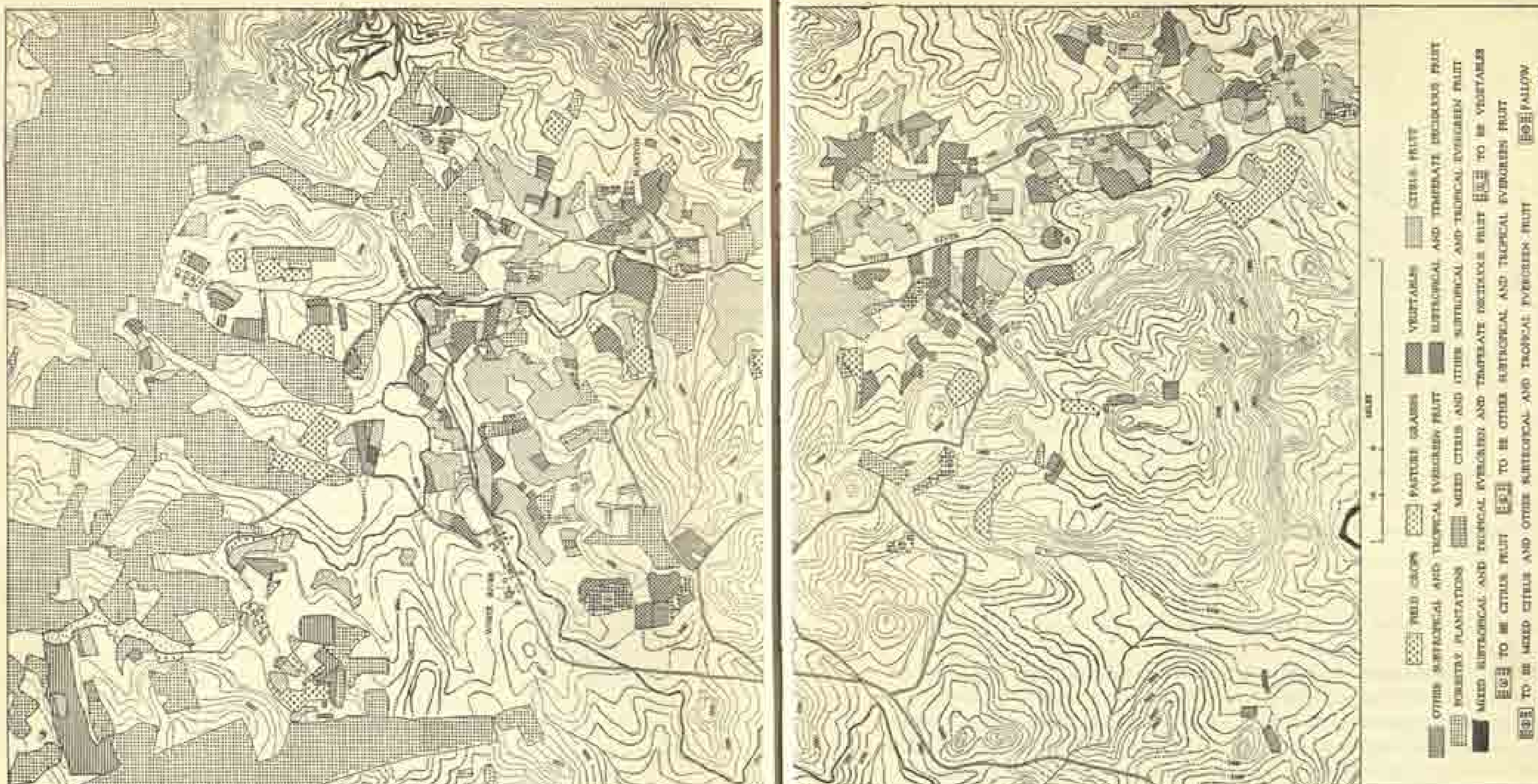

Fig. 209. The Lowveld; land utilization in the White river valley.
(Courtesy Geographical Publications Ltd.)

under irrigation, beef fattening is possible in the valleys – and is already practised near Kaapmuiden.

Within the Lowveld there are striking contrasts in the economy occasioned by differences in the physical environment, in land ownership, date of settlement, and proximity to transport facilities. Thus whereas the Elands river valley, naturally endowed with fertile well-drained alluvial soils and served by the Pretoria–Lourenço Marques railway, is an area of long-established prosperous

farms producing a variety of fruit, vegetables, and field crops, the upper Crocodile valley, with its heavy ill-drained clay soils and lack of rail facilities, is agriculturally backward, its poor farms having only limited areas of cultivated land used mainly for cereals and the odd orchard of neglected naartje trees. Farther east the White river valley (Fig. 209 and Plate 109), an area of small farms served by a Government irrigation scheme, contrasts with the Middle Crocodile valley (Fig. 210) where the agriculture is dominated by the activities of two large companies and a

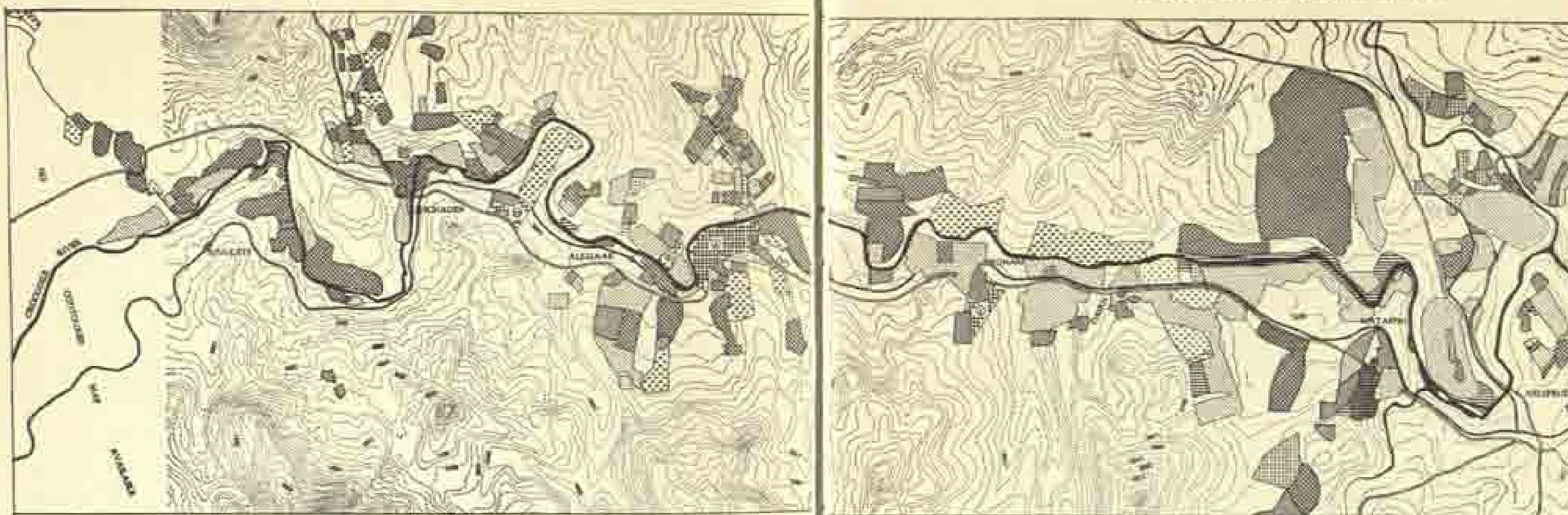

Fig. 110B.

number of large estates. In both sub-tropical fruits, particularly citrus, are the main concern, while the growing of flowers for the Johannesburg winter market is important on very small farms along the White river. Specialized carnation growing is a feature of Magoebas Kloof, west of Tzaneen. The newer farms around Malelane in the Crocodile river valley grow mainly vegetables but as capital is accumulated fruit trees are planted. In the less accessible tributary valleys of the Crocodile river field crops such as groundnuts, sweet potatoes, and 'stokroos' are grown to provide the capital necessary for fruit growing.

Contrasting with the European areas the traditional agriculture based on the rearing of cattle and growing of maize is carried on in the Bantu areas. A beginning has been made with fruit, vegetables, and field crops under irrigation along the Komati and Lomati rivers in Swaziland and bananas and other fruits are successfully grown on Native Trust farms near Sibasa in the Transvaal.

The development of agriculture in the Lowveld has been attended by numerous difficulties, most serious being those associated with soil nutrition, pests and diseases, and suitable plant varieties. Under cultivation the lateritic soils

present many difficulties. The same processes responsible for the removal of the more soluble constituents of the soil soon get to work on fertilizers. The bases – calcium, magnesium, and potash – are rapidly leached away, while the phosphorus reacts with the aluminium and iron compounds to become fixed and unavailable to the plants. Organic manure is quickly mineralized and it is difficult to build up the humus content. Further difficulties arise from the fact that the warm weather conditions favour the accumulation and spread of soil-borne diseases and parasitic nematodes which particularly attack the vegetable and field crops. This necessitates the constant breeding of new and resistant plant varieties. Difficulties, however, are experienced here for many of the crops grown have been introduced from countries in which scientific methods have not been practised, e.g. mangos from India, litchis and tung-nuts from China. In the absence of accepted varieties both yields and fruit quality have been poor. Due largely to the work carried out at the Sub-tropical Horticultural Research Station at Nelspruit and the Barberton Cotton Experimental Station, however, suitable fertilization programmes are being evolved and new plant varieties bred.

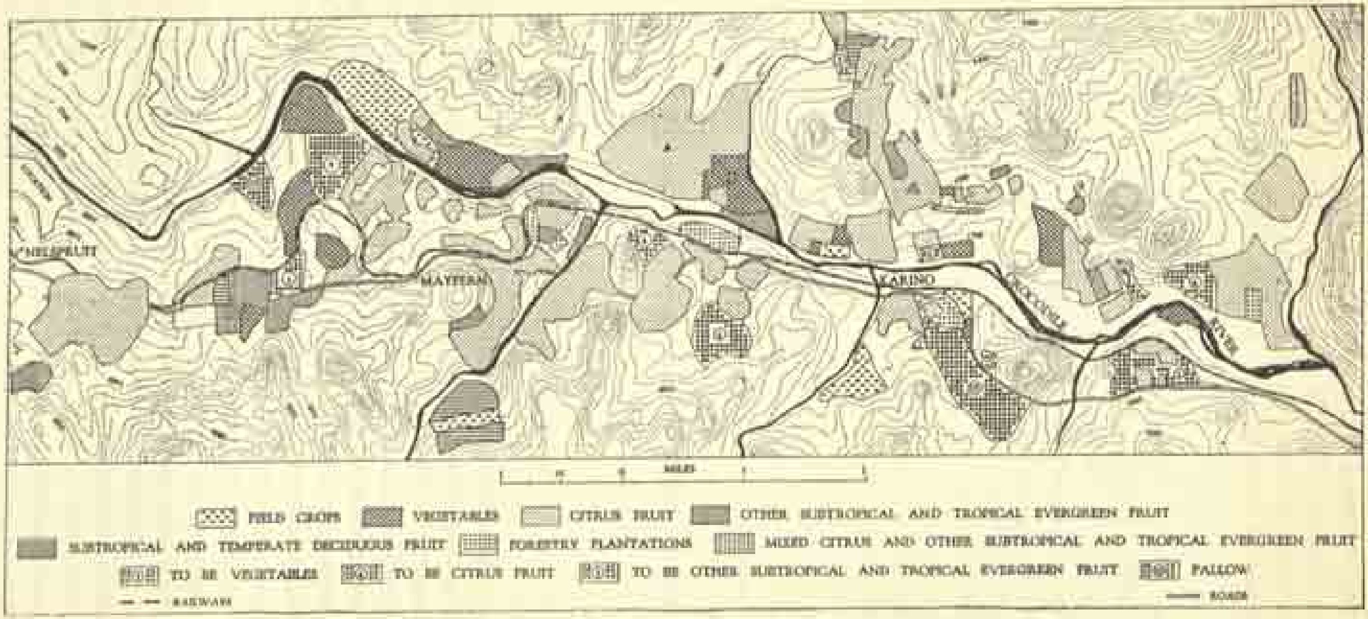

Fig. 210b. The Lowveld; land utilization in the middle Crocodile river valley.
(Courtesy Geographical Publications Ltd.)

Large areas still await development in the Lowveld. Their fuller utilization will, however, depend very much on export markets – the existing production of fruit and vegetables being more than adequate for Union needs – while it may be limited by the dearth of sites suitable for irrigation dams (see ch. 7, pp. 138–41).

The Coastal Belt

Lying below 2,000 feet and extending westwards to the high ground associated with the Lebombo monocline the coastal belt varies in width from only 3 miles in the south where the monocline reaches the coast to over 50 miles in the north. At the same time its character changes with the nature of the underlying rocks. In the south where underlain by Table Mountain Sandstone it comprises low plateaux deeply trenched by the narrow gorges carved by the trunk rivers, notably the Umzimvubu river which reaches the sea at Port St Johns (Plate 111). Between Port Shepstone and Richards Bay the surface developed over Karoo beds is generally undulating while farther north the Cretaceous sediments in places covered by Tertiary and Pleistocene sands give rise to a featureless lowland. Here the river courses are parallelled by considerable stretches of alluvium.

The coastline is one of considerable geomorphological interest. It owes its general form to structural influences and its finer physiographic features to the nature of the rocks in which they are fashioned. Structurally two distinct sections are recognizable; for south of the Umlalazi river the Lebombo monocline reaches the sea and the coastal features are cut in Karoo and pre-Karoo rocks whereas to the north the coastline marks the seaward margin of the plain of Cretaceous to Recent sediments, which has emerged from beneath the sea in recent times.

South of the Umlalazi river the coastline is remarkably smooth, yet it cuts obliquely across the Lebombo monoclinal axis near Port Shepstone and farther south it similarly cuts the northern part of the Cape Folded Belt. It is clearly structural in origin; whether due primarily to faulting or flexuring, however, is still disputed, as also is its connexion with the break-up of Gondwanaland. Throughout most of its length the coastal zone is characterized by a sandy beach backed by a belt of sand dunes behind which the margin of the solid land mass varies in form with the nature of the rocks involved. Between the Umtata river and Port Shepstone where the Lebombo monocline reaches the coast, the Table Mountain Sandstone is responsible for the high cliffs which characterize the 'Wild Coast' of Pondoland. These produce the most magnificent scenery where breached by the deep gorge of the Umzimvuba river at Port St Johns. Farther south where the Beaufort beds outcrop fairly steep cliffs have been cut into the sandstone and dolerite but over the shales the land rises gently towards the interior. North of the Umkomaas river a low sandy plain extends from the dune belt to the outcrop of the Ecca and Dwyka beds over which the slope steepens landwards.

Everywhere along this coast sandbars block the mouths of the rivers (Plate 112). The smaller rivers are able to break through to the sea only during the

rainy season and even the larger rivers maintain only a narrow and shallow channel during the dry season.

North of the Umlalazi river the coastline of Zululand is characterized by sandy beaches backed by sand dunes rising in places to over 400 feet and covered with a dense growth of thorny succulent bushes. The more powerful rivers break through the dune barrier to reach the sea but usually parallel the coast for some miles and open out into lagoons before finding a suitable exit. The largest lagoon, Lake St Lucia, is about 35 miles long. Fed by the Mkuzi and three smaller streams it is bordered by mangroves near its mouth where the combined flow of the lake and the Umfolosi river force an outlet to the sea. Richards Bay and Kosi Lake have shallow outlets but Lake Sibayi, which may represent the old lagoon of the Pongola river, has no outlet to the sea.

The generally high temperatures and fairly well-distributed rainfall characteristic of this sub-region favour the cultivation of a number of sub-tropical crops. Sugar cane is by far the most important. It covers most of the rolling country between Port Shepstone and St Lucia, occupies the drained flood plain of the Umfolosi river near Mtubatuba, and ascends the hillsides towards Eshowe. The sandy soils of the coastal strip, however, carry timber plantations mainly of *Eucalyptus saligna* which protect the canefields from windblown sand. North of Hluhluwe where the rainfall is inadequate for sugar cane the bush-covered country is used mainly for cattle rearing. South of Port Shepstone where the temperatures are too low, the coastal plateaux are used either for wattle and timber plantations as near Lusikisiki or for maize cultivation and cattle rearing. Here the narrow strips of level land along the river gorges are utilized for tropical fruits, especially bananas. The hilly country in the coastal belt north of Durban is the zone of Indian farming, concerned mainly with the production of sub-tropical fruits, especially bananas, mangos, and papaws, and horticultural crops. Vegetables are grown on the flat land along the rivers while banana plantations climb the hillsides. This type of farming extends inland along the road and railway linking Durban and Pinetown, where it is intermingled with dairying and poultry rearing carried on by Europeans.

The sub-tropical climate, attractive coastal scenery and sandy beaches bring tourists to the coast throughout the year but particularly in winter. The most popular section extends for some 100 miles from Umhlanga Rocks north of Durban to Port Edward south of the city. Here there are numerous resorts – the sandy beaches are attractive to holiday makers, bathing is safe when the rivers are low, and the flat land behind the sandbars closing the river mouths provides excellent sites for golf courses. St Lucia and Richards Bay are popular with anglers and with campers while Port St Johns and the Wild Coast of Pondoland attract those seeking fine scenery.

Good harbours are rare along this coast, for nearly all the river mouths are closed by sandbars through which the rivers cut a passage only when in flood. Port Shepstone and Port St Johns have been used in the past for small ships but

they are dangerous; only Durban has developed into a major port (see ch. 33, pp. 503–6).

In 1904 the borough of Durban comprised about 6,000 acres and had a population of 67,847 people. Today it spreads over 45,000 acres or about 70 square miles and has a population of 432,670.[11] This great growth has been due primarily to the function of Durban as premier cargo port of South Africa, serving as the main outlet for the most richly endowed part of the country. The growth of trade, however, has stimulated the development of industry so that today Durban is both port and industrial city as well as commercial centre and holiday resort. Trade and industry have attracted people of all races and today with a population of 132,561 Europeans, 146,935 Asiatics, 16,654 Coloured people, and 136,520 Africans, Durban is racially the most complex of all South African cities.

The spread of Durban and the evolution of its urban pattern with its distinct residential and industrial zones have been directed very largely by the relief. In this respect Durban has experienced site difficulties greater even than those of Cape Town. The only level land occurs on the flats formed of alluvium, deposited by the several rivers entering or formerly entering the bay (see ch. 33, pp. 503–4), mixed with wind-blown sand from the coastal dune belt (Fig. 211). This land was subject to annual flooding by the rivers and most of it required draining. South of the bay Pleistocene deposits, mainly sandstones, build the steep-sided ridges of the Bluff, rising to 200 feet, and Wentworth ridge (Fig. 212). West of the flats similar deposits produce the high ground of the Berea while inland the outcrops of Karoo and pre-Karoo rocks give rise to hilly dissected country.

The site of the first settlement was on the northern side of the bay between the modern fishing and T jetties. This is now the commercial and distributive centre of the town with the main shopping street running from west to east to the Marine Parade and Indian ocean. During the late nineteenth and early twentieth century European residential development climbed the high ground of the Berea while light industries sprang up in the Point area. After the first world war, when the Government undertook the large reclamation scheme at the Bayhead, industrial sites were established around Maydon Wharf and in Congella. First opened in 1925 this area has become the centre of Durban's major industries (Fig. 213) including the large soap and margarine works of Lever Bros, paint and fertilizer manufacture, the preparation of wattle extract, etc. By 1938 all the industrial sites had been taken up, while the land extending southwards around the western end of the bay had been developed by private enterprise, factories being erected particularly in Jacobs but also Wentworth and Clairwood. Meanwhile with a view to providing for future industry, in 1931 the Durban city council acquired an area of 3,000 acres along the south coast road between the Umhlatuzana and Umlaas rivers. Preparations for an industrial estate were interrupted by the war but since 1946 the level land adjacent to the road has been laid out as the Mobeni industrial estate while the hilly land towards the interior

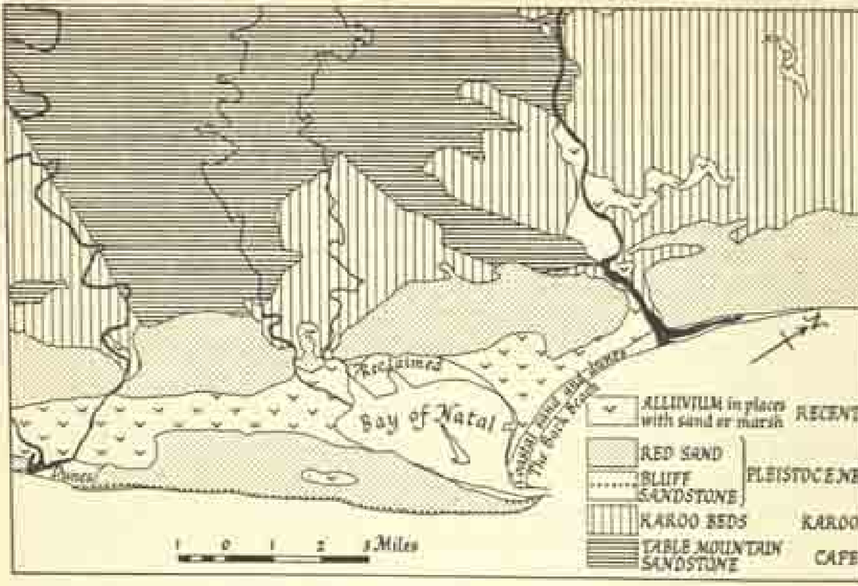

Fig. 211. The site of Durban; geology.
(Geological outlines after L. J. Krige.)

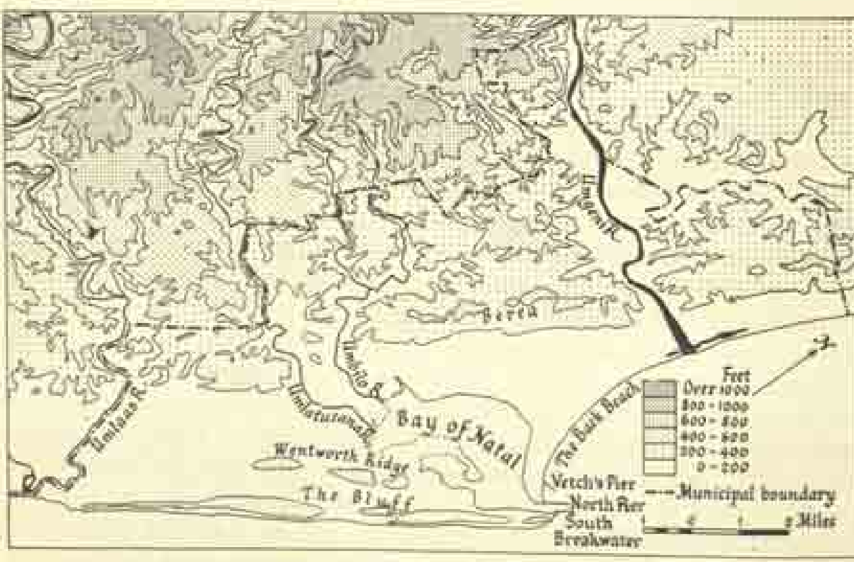

Fig. 212. The site of Durban; relief and drainage.

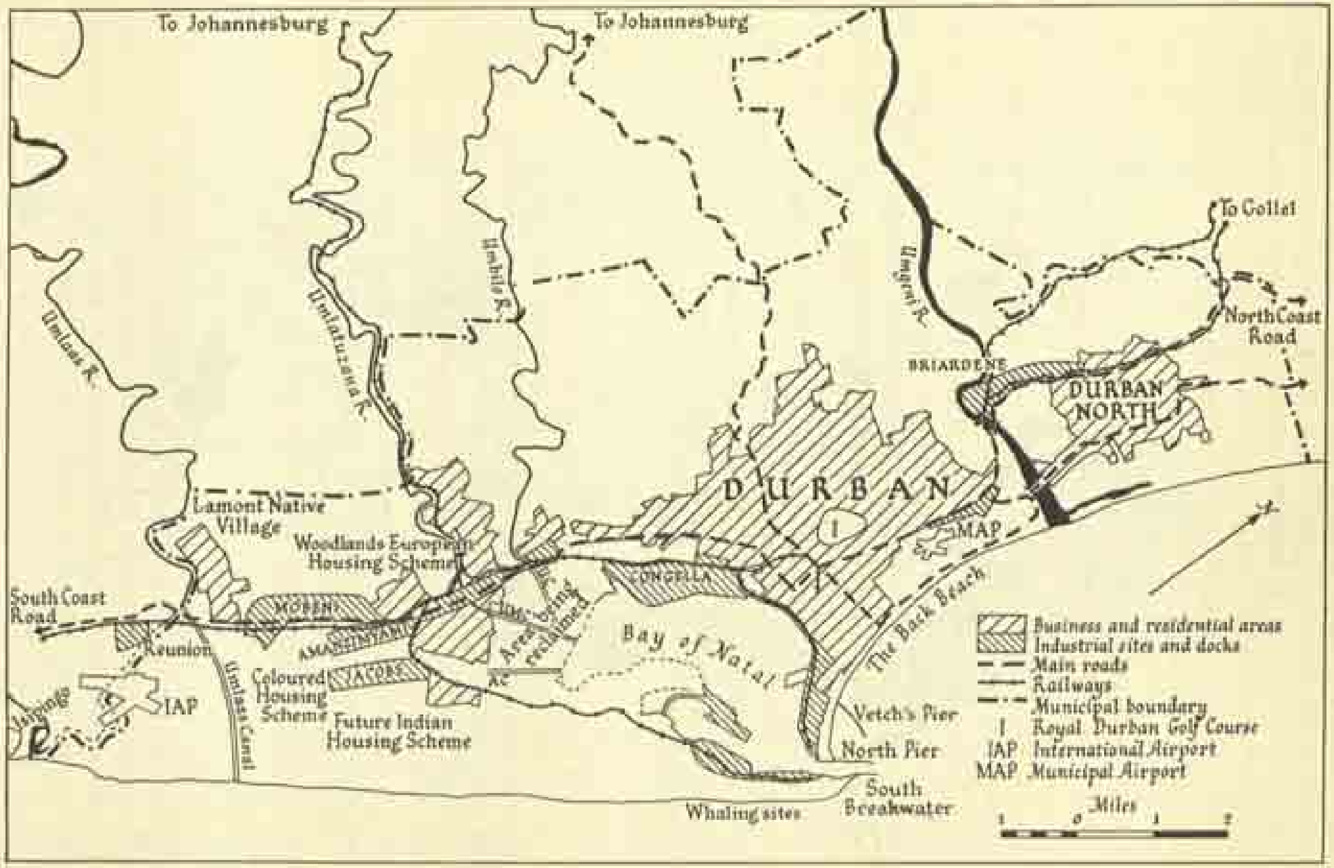

Fig. 213. Durban; urban land use.
(Industrial areas from map in brochure *Industrial Durban*.)

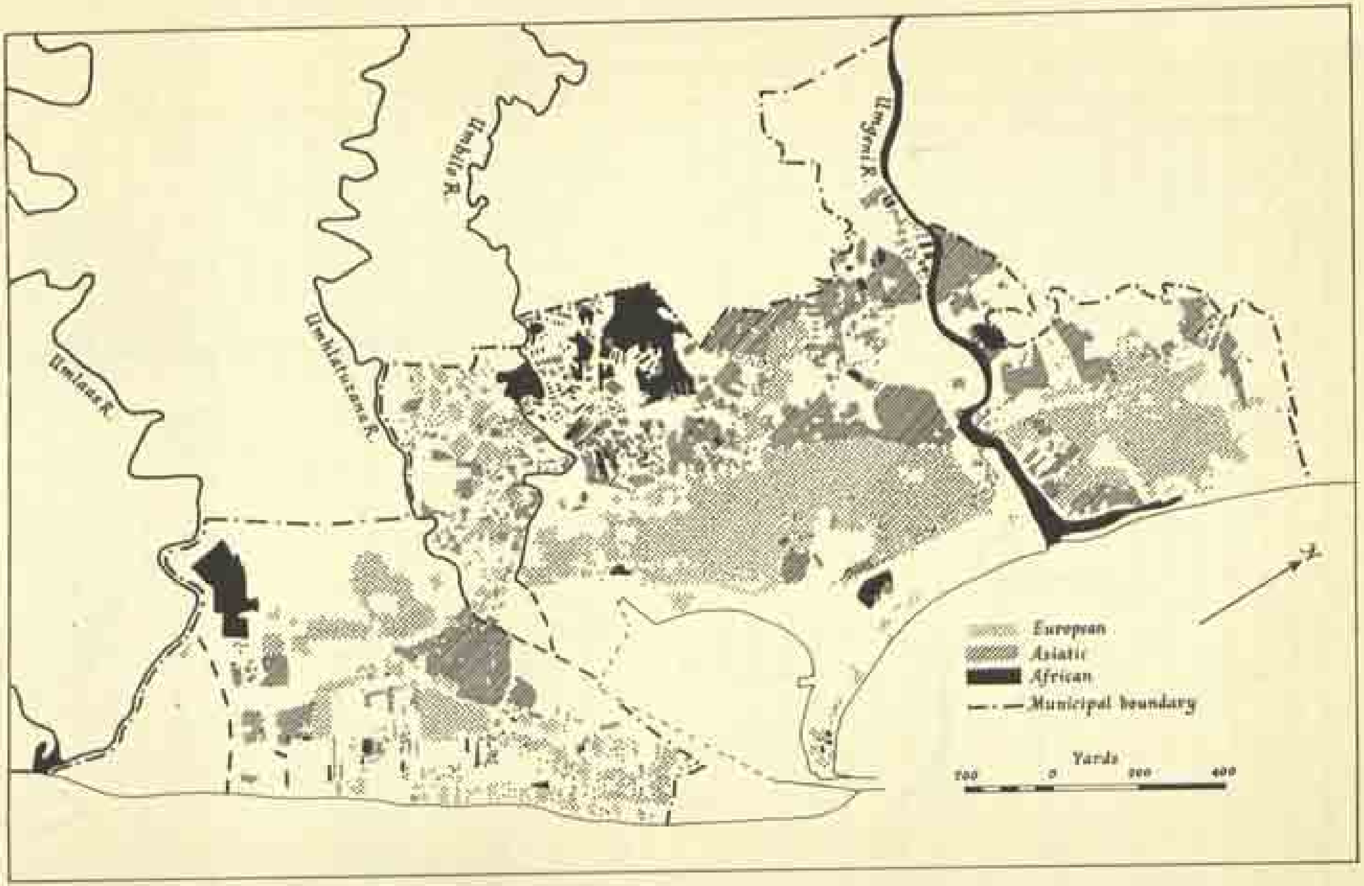

Fig. 214. Durban; racial occupation in 1950.

(From a map supplied by the City Engineer and Town Planning Officer.) *Note:* The limited areas occupied by Coloured people occur within the European occupied areas in Dalbridge (east of Congella) and Durban North and within the Asiatic occupied areas of Sydenham and Sherwood (north of the Berea) and Jacobs.

has been used for the Woodlands European residential area in the north and Lamont Native village in the south. In addition the city council has acquired the Amanzimnyama estate which is being developed as an industrial zone linking Jacobs with Mobeni. A second bayhead reclamation scheme involving the canalization of the Umbilo and Umhlatuzana rivers has made available further level land immediately adjacent to the bay. Most of this, however, has been allocated to the South African Railways for the establishment of marshalling yards and workshops, some provision has been made for the development of a shipbuilding industry in the future, and only a comparatively small area is to be used for other industrial purposes.

Concomitant with the growth of industry has been the spread of residential development. While industry has taken up most of the level land around and south of the bay, the attractive higher land of the Berea and the Bluff has been developed for European residence (Fig. 214) while the land adjacent to the Back Beach and fronting the Indian ocean has become the scene of large hotels and fine blocks of flats providing for the tourist industry. Since 1946, with the great growth of population the areas of European residence have leapt the Umgeni river and Durban North has grown up as an almost detached outlier of Durban. While the Europeans have thus built over the higher ground the Indians have occupied the lower ground particularly back of the Berea, in the bayhead area, and along the Umgeni and Umhlatuzana rivers. Here the suitability of the land for market gardening and banana cultivation naturally attracted the Indians while until 1932 these areas lay outside the incorporated area of the city and therefore were not subject to control over land occupation.[12] The Africans, latercomers, attracted by the opportunities for employment in industry, live farther out, particularly in southern Cato Manor west of the Berea. Here they live under congested conditions in close proximity to the Indians (Plate 114), many of whom act as traders among them. This area of racial intermingling was the scene of the main Durban riots in 1949.

Today the main problems confronting the further expansion of the town are the provision of level sites for industry, the provision of residential areas for all sections of the population in conformity with the Group Areas Act and the co-ordination of development so that the journey to work is relatively easy for all people. Two possibilities are open – the further spread of industry and with it residential areas southwards along the south coast road or growth inland towards Pinetown. In the latter direction ribbon development is already evident while Pinetown itself is already developing as a small industrial centre with textile mills, etc. In whichever direction development proceeds access will be a major problem for the south coast road and the Durban–Johannesburg road are virtually the only outlets from the city and already carry considerable traffic including, at the weekends, Durban residents seeking the beaches or the hills.

BIBLIOGRAPHY

1. See L. C. KING. *South African Scenery*. Edinburgh, 2nd edition, 1951, pp. 239–54.
2. J. H. WELLINGTON. 'The economic development of the Eastern Cape Province'. *S.A.G.J.*, Vol. II, 1928, pp. 22–37.
3. See J. A. PENTZ. *The Value of the Botanical Survey and the Mapping of Vegetation as applied to the Farming Systems in South Africa*. Bot. Surv. of S.A., Mem. No. 19, 1938.
4. K. BUCHANAN and N. HURWITZ. 'Land use in Natal'. *E.G.*, Vol. XXVII, No. 3, 1951.
5. T. J. D. FAIR. 'Agricultural regions and the European rural farm population of Natal'. *S.A.G.J.*, Vol. XXXIV, 1952.
6. Union of South Africa, Department of Agriculture, Division of Economics and Markets. *Agro-Economic Survey of the Union (IV), Diversified Farming Areas East of the Drakensberg Range*. Dept Agric., Bull. No. 309, 1950.
7. D. M. DOVETON. *The Human Geography of Swaziland*. I.B.G., 1937.
8. *Official Yearbook of the Union of South Africa and of Basutoland, Bechuanaland Protectorate, and Swaziland*. No. 27, 1952–3, p. 1312.
9. PETER SCOTT. 'Land policy and the Native population of Swaziland'. *G.J.*, Vol. CXVII, Pt 4, 1951.
10. See MONICA M. COLE. *Land Use Studies in the Transvaal Lowveld*. World Land Use Survey, Occasional Papers No. 1, Geographical Publications Ltd. London. 1956.
11. *The City of Durban*. Official Guide. Cape Town. 1953.
12. See H. C. BROOKFIELD and M. A. TATHAM. 'The distribution of racial groups in Durban'. *G.R.*, Vol. XLVII, No. 1, 1957.

39

The Highveld Plateau

The Highveld Plateau forms a vast extent of level country sweeping inland from the Great Escarpment to terminate against the southernmost ridge of the Bankeveld in the north and the Langebergen and Korannabergen in the north-west. The first-mentioned boundary lies to the north of the Griqualand–Transvaal axis of uplift, the second coincides with it. The Kaap plateau forms part of the Highveld but is nearly detached from it by the embayment of Middleveld along the Vaal and Hartz river valleys produced by the headward erosion of these streams into relatively soft Karoo rocks. Here the boundary is clearly defined, as the Campbell Rand, marking the eastern edge of the Kaap plateau, forms a sharp escarpment overlooking the valley. Farther south there is no obvious break of slope and the country merges with the Cape Middleveld. Thus defined the Highveld is co-terminus with the stretch of country standing at an average elevation of between 4,000 and 6,000 feet above sea-level, which has undergone relatively little dissection since Cretaceous times and today shows extensive remains of former peneplains or pediplains.

The present surface features can be understood only in the light of their evolution since Karoo times, when the pre-existing landscape was buried by great thicknesses of shales and sandstones more or less horizontally disposed and subsequently intruded by dolerite dykes and sills and topped by basaltic lava flows. Erosion commenced and by the late Mesozoic period had succeeded in producing a planed lava surface, remnants of which may still be seen in Basutoland. From the surrounding regions the Gondwana cycle began its attack and by early Cretaceous times had transformed the area now occupied by the Highveld into a vast peneplain, developed mainly on Karoo beds but cutting across the rocks of the Transvaal and Ventersdorp Systems in the north-west. At the same time great scarps were formed about the volcanic region.

The present surface features result from the attack of erosional forces upon this ancient landscape. In this stream action has played a very important part. The present drainage was initiated on the Karoo surface but was disturbed, first, by the break-up of Gondwanaland and subsequently, by warpings during

Tertiary times, which steepened the gradients in the headwater regions of the Orange–Vaal and Limpopo systems but lessened them downstream. As a result dissection has continued near the Drakensberg and along the Griqualand-Transvaal axis but the Gondwana peneplain has been preserved elsewhere. Where the surface is remarkably level, as in the north-western Free State, deposition is evident. Everywhere the actual land-forms owe much to the nature of the underlying rocks.

Over the greater part of the region the surface, lying at an altitude of 4,000 to 6,000 feet, is monotonously level (Plates 65 and 118), only an occasional kopje, capped by resistant sandstone or dolerite, breaking the otherwise featureless horizon. This is the Highveld proper, owing its characteristic features to the extent of the Gondwana peneplanation and to the fact that the greater part of it is underlain by horizontally disposed sandstones and shales and sheets of dolerite. In the south-west, however, where the Highveld merges into the Upper Karoo (Plates 119 and 120), kopjes become a more characteristic feature of the landscape and mark the transition to the Cape Middleveld.

In the northern Free State and southern Transvaal the plateau surface is broken where increased surface dissection, following uplift along the Griqualand-Transvaal axis, has removed the Karoo cover and exposed ancient ridges of Transvaal and Witwatersrand quartzites in the Vredefort dome, the Gatsrand, the Witwatersrand, and the Bankeveld (Fig. 215). It is, however, carried across the outcrops of the Ventersdorp lavas and the Dolomite being broken only by the embayment of Middleveld along the Vaal and Hartz valleys where the rivers, excavating into soft Karoo rocks, have caused the encroachment of the African erosion cycle. To the west of the Hartz valley the Kaap plateau, like the other dolomitic areas is characterized by sink-holes and strong springs, but differs from them in being covered with a layer of lime accretion resulting from the low rainfall and high evaporation in this western area. Still farther west the Gondwana surface is continued across the Griquatown and Matsap rocks to terminate along the ranges of the Langebergen and Korannabergen formed by resistant rocks brought up along the Griqualand–Transvaal axis of uplift.

Towards the Drakensberg the plateau surface is again more varied. East of Bloemfontein the flat-topped Thaba 'Nchu mountain and the Renosterberg represent outlying portions of the Basuto Highlands towards which the country proceeds in a series of steps formed by the more resistant beds of the Stormberg Series at the top of the Karoo System. The Basuto Highlands (Plate 129), carved by stream action into a maze of pinnacles and towers of cream-coloured Cave Sandstone capped by dark basalt separated by deep gorge-like valleys in the underlying shales, present a landscape which contrasts sharply with the true Highveld. But to the east of the Maluti mountains, where the dissection is greatest and the scenery most magnificent, the lava forms an upland plateau between 8,000 and 11,000 feet above sea-level. The Basuto Highlands in fact form part of the plateau where stream dissection, strengthened by continued

uplift, sustained by high altitude and heavy rainfall and aided by the varying resistance of underlying rocks, has been particularly strong.

In striking contrast to the Basuto Highlands is the Sandveld of the north-western Free State with its characteristic pans and indeterminate drainage. Here, near the western rim of the Karoo–Basutoland depression, the surface is remarkably level and the stream gradients slight. Only with difficulty do the tributaries effect a junction with the main rivers. Loose sand, weathered from the underlying Ecca sandstones, mantles much of the surface and is blown about by strong winds during the winter months. The deposition of this sand in a watercourse or even the falling in of its sandy banks after the prolonged droughts which afflict this area may so choke the stream that even when it is next in flood it is unable to remove the debris; a continuation of this process gradually dismembers the stream and converts it into a series of pans.[1]

A similar area of pans and indeterminate drainage occurs in the Lake Chrissie area in the eastern Transvaal where the Vaal river has captured the headstreams of the Umpilusi river and their beheaded portions have become converted into a series of pans as a result of sand deposition.[2]

The greater part of the Highveld plateau is drained by rivers flowing westwards to the Orange–Vaal system. Initiated on a Karoo surface, over most of the area the major rivers still flow over rocks of this age but have become entrenched as a result of Tertiary and later uplift. In the northern Free State and southern Transvaal, however, with the gradual stripping of the Karoo cover, the rivers have become superimposed on to the ancient landscape below, which they traverse without regard to structure. Thus, today, the Vaal river cuts through the ridges of the Vredefort dome in a narrow gorge (see Fig. 49) while both upstream and downstream its normal flow is interrupted at intervals by dolerite dykes which cross its course. At such places there are opportunities for the diversion of water for irrigation purposes. The Vaal is fed by a number of north-bank tributaries which have their sources in strong springs or eyes at the southern margin of the Dolomite. Today this dolomite country carries little surface drainage but prior to the removal of the Karoo cover it appears to have carried the headstreams of the Molopo and Hartz rivers, the former courses of which are marked by lines of gravel terraces (see Fig. 215). With the removal of the Karoo beds the streams disappeared underground and the waters were gradually tapped by the tributaries of the Limpopo and Vaal.[3] The gravels were diamondiferous and led to the early 'mining' activities and settlement in the area. More important today, however, are the opportunities for irrigation afforded by the perennial streams fed by underground water stored in the Dolomite. On the Dolomite itself and in the areas underlain by the Ventersdorp lavas good supplies of underground water may be obtained from relatively shallow boreholes. Thus the southern Transvaal and northern Free State are quite well watered. Over the rest of the plateau, however, except in the vicinity of the main rivers, surface water is scarce and reliance has to be placed on somewhat unreliable underground supplies.

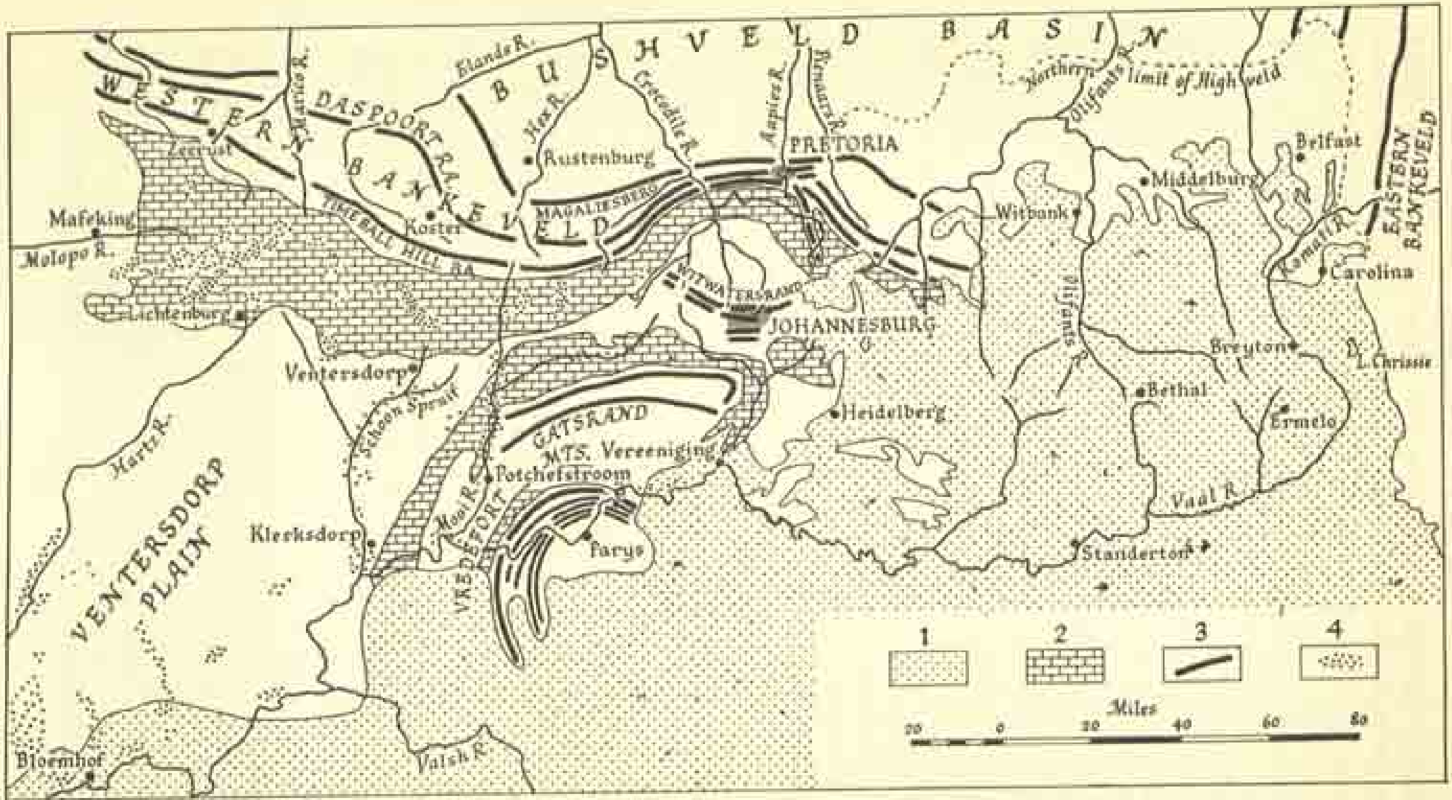

Fig. 215. The Vaal-Limpopo watershed and adjacent areas.

(After J. H. Wellington.)

1. Karoo beds and dolerite. 2. Dolomite (Transvaal System). 3. Prominent ridges. 4. Gravel terraces. The unshaded area is underlain by pre-Karoo rocks.

From the foregoing it is clear that their surface features distinguish the extensive featureless plateau of the Highveld proper, the dissected mountainous country of Basutoland, the diversified country of the southern Transvaal and northern Free State and the waterless Kaap plateau from one another.

Over the whole region the climate[4] is characterized by low rainfall, many days of cloudless skies and considerable diurnal changes of temperature. The seasons are highly contrasted, the summers being warm and rainy, the winters cool and dry (see Fig. 216). In winter the region comes under the influence of warm dry air brought by north-westerly winds from the high-pressure belts of the continental interior. Fine cloudless days on which the temperatures often rise above 60° F. are followed by cold nights during which the minima fall below 35° F. over most of the area and below 30° F. on the higher ground in the east. In the valleys and depressions, where morning mist reveals inversions of temperature, even colder conditions are experienced. From time to time this characteristically calm winter weather is interrupted by outbursts of bitterly cold Polar air which sweeps over the Southern Escarpment and across the plateau. From August onwards, however, easterly winds bring in moist air from over the Indian ocean and in September temperatures rise rapidly. The Highveld proper, nevertheless, remains remarkably cool for the latitude; maxima seldom rise above 80° F. and night temperatures of 50° to 60° F. are usual. But towards the west and in the Upper Karoo the days are markedly hotter and maxima exceeding 90° or even 100° F. may be experienced. The rainfall comes mainly in the form of thunder-showers and is frequently of high intensity and sometimes destructive. Moreover it is unreliable. Over the southern Transvaal and eastern Free State it varies between 20 and 40 inches, which is adequate for crop production, but it falls to 15 inches on the Kaap plateau and decreases westwards across the Free State and central Cape to less than 10 inches in the Upper Karoo. In these directions too the rainfall comes later in the season and is increasingly unreliable. Years may pass without any rain at all and often the drought is broken by torrential downpours which cause widespread floods. In the vicinity of the Escarpment, on the other hand, where the thunder-showers are supplemented by orographic rainfall the total exceeds 50 inches and in places 70 inches, while mist is frequent. The most favourable distribution occurs in the south-eastern Transvaal where, due to the absence of a well-defined Escarpment (see ch. 1, p. 24), the rains are usually gentler and of longer duration. Hence on climatic grounds the Kaap plateau and the Upper Karoo are distinguished from the Highveld proper by their hotter summers and general aridity while the Basutoland mountains and the high land in the vicinity of the Escarpment are distinguished by cooler conditions throughout the year, greater and more evenly distributed rainfall and frequent mists.

These variations in climate, surface form, and underlying geological formation are translated in the character of the soils and the type of vegetation. Thus the moister eastern areas, underlain by shales and sandstones, are characterized by

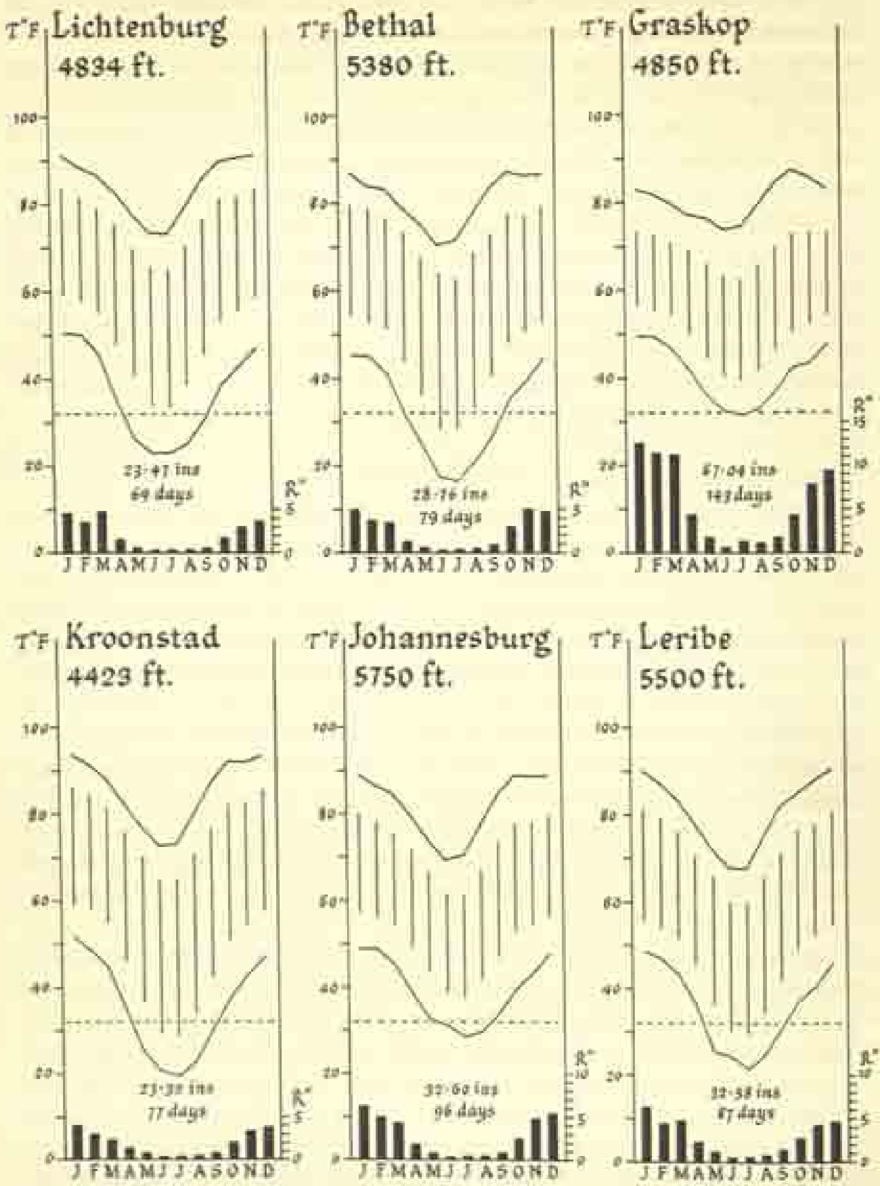

Fig. 216. Cartograms of mean monthly rainfall and temperature at selected stations on the Highveld Plateau.

Mean daily maximum and minimum temperatures are given by the upper and lower ends respectively of the vertical lines; the continuous lines above and below represent the mean monthly maxima and minima.

gley-like podsolic soils which support a vegetative cover of mixed grasses. In the Basutoland mountains lower temperatures are responsible for the transition to short grassveld where the basaltic lavas have weathered to relatively fertile soils; where, however, the surface drainage is poor a sub-alpine type of vegetation comes in. In the extreme west the increasing aridity brings about a transition to alkali accumulating soils and the vegetation changes to thornveld in the north and to desert scrub towards the Karoo.

Thus the main elements of the physical environment combine to distinguish the Highveld, the Kaap plateau, the Basuto Highlands, and the Upper Karoo from one another. They materially influence the opportunities for human occupance and economic activities which are best discussed on a sub-regional basis. Here the transcending nature of the cultural influences are of such importance, however, that Basutoland is best considered as a whole, i.e. the plateau lands east of the Caledon river with the Basuto Highlands and not with the Highveld.

The Highveld

Both agriculturally and industrially the Highveld is the most important region in the Union. It accounts for 60 per cent of the maize crop, 30 per cent of the wheat, most of the kaffir corn, groundnuts, sunflower seed, field beans and cowpeas, and potatoes produced in the country as well as large quantities of meat, dairy produce, wool, hides, and skins; it contains the major mining and industrial areas and supports the one great conurbation of the country in the Witwatersrand. And this has been achieved in little more than half a century. The area was reached by the Voortrekkers during the middle of the last century and experienced the influx of miners from 1870 onwards but until 1900 it remained essentially a land of large stock farms with a series of mining towns, little more than camps, strung out along the Witwatersrand. The farms provided only the immediate needs of the family in food and fats and furnished a surplus of oxen from the sale of which clothing and other necessities of life were bought. After the Anglo-Boer war, however, the picture changed and in the short space of half a century the region has passed through the phases of extensive stock farming and large-scale maize production and has now entered the stage of a mixed agricultural economy with in some places the emphasis on grain production, in others on milk or meat. At the same time the mining camps have become supply centres and industrial towns while Johannesburg (Plate 122) has developed into a commercial and industrial city of over a million people.

Agriculture

Throughout this period the demands of the Rand market have exerted a strong influence on agricultural development within, of course, the limits imposed by the physical environment. Thus the diversified country of the southern Transvaal and northern Free State, known as the Hardveld, with its abundant surface water and opportunities for irrigation, has naturally focused its attention on

perishable produce for the nearby market, whereas the more distant central Free State and eastern Transvaal, crossed only by a few trunk rivers but receiving adequate rainfall for summer crops has concentrated on grain and other non-perishable food crops grown under dry land conditions.

The Diversified Country of the Southern Transvaal and Northern Free State. The opportunities for agriculture within this belt vary with the relief and soil conditions and the availability of water for irrigation. The rugged quarzite ridges of the Witwatersrand, Gatsrand, and Vredefort Dome are sterile but the valleys, especially where they carry soils derived from alluvium and diabase provide fertile irrigable lands, which are utilized for the production of vegetables, fruit and flowers, milk, eggs, and poultry for the Witwatersrand and Vereeniging markets. Naturally there is some specialization and notably vegetables and fruit production is most important near the towns where the holdings are very small, often only a few acres, while dairying is more important further afield where land values are lower and farms larger. Within Johannesburg small holdings worked intensively by Portuguese market gardeners occur along each small stream. Orchard fruits especially peaches and apricots are grown on the light loams derived from granitic rocks north of the city. The Klip and Mooi river valleys are primarily concerned with fluid milk production. Around Parys,[3] which is sheltered by the ranges of the Vredefort Dome and enjoys a warmer climate than the Mooi river valley, fruit and vegetable production is combined with dairying.

Agriculture within this region is intimately bound up with the continued growth of the Witwatersrand Conurbation and the Vereeniging industrial area. With every extension of urban growth the agricultural zones move out. Inevitably there is some conflict, notably today in the Jukskei river valley north-east of Johannesburg where agricultural, industrial and residential interests compete for the land. Near the city, small dairy farms which have to buy the bulk of their feed requirements are finding it increasingly difficult to compete with larger farms, strung out along the main railways to Durban, Bloemfontein, and the Free State-Basutoland border, which have adequate natural pasturage, and are able to produce maize for silage and for hay, and at the same time enjoy the advantages of rapid rail transport to the consuming centre. Thus as the influence of the Witwatersrand Conurbation extends in ever widening circles, fluid milk production is extending into the neighbouring arable belt. Vegetable production, however is declining for fertile irrigable land is scarce, so that increasingly the big towns are having to draw their supplies from farther afield.

The Dryland Farming Area. Largely coincident with the so-called 'maize triangle' the area extending from the Drakensberg westwards as far as a line drawn through Lichtenburg, Schweizer Reneke and Wepener is the most important agricultural region in southern Africa. Today it is one of mixed farming. Maize is still the main crop (Plate 116) but wheat is an important source of income in some areas, other grains, hay and silage crops, and potatoes are also grown, cattle are kept for meat and dairy produce, and sheep for meat and wool. Farms average

between 1,200 and 1,500 acres (600 and 700 morgen)[8] but there is a general tendency towards subdivision particularly near the urban centres and main railway lines where dairying is profitable. Throughout the area the labour is provided by Native squatters who are employed thoughout the year and are paid in cash as

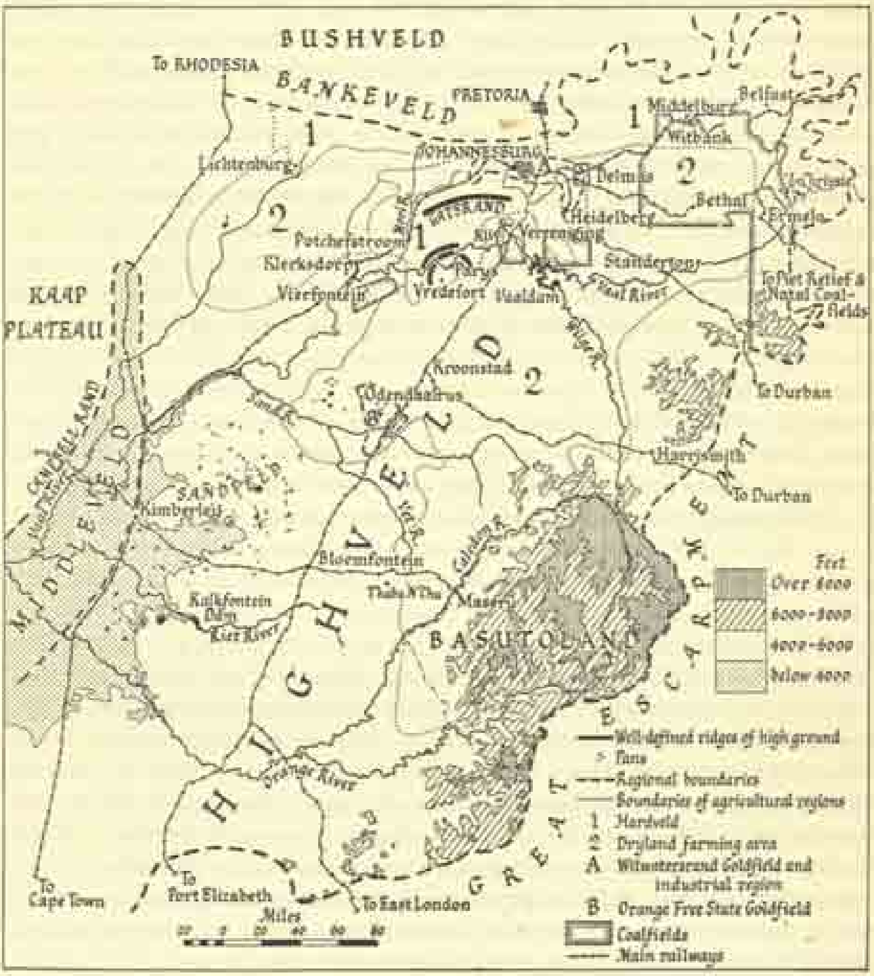

Fig. 217. The Highveld.

well as in land and grazing rights. Beyond these generalizations there are important differences of emphasis according to the prevailing climatic and soil conditions.

The most favoured area lies in the eastern Transvaal where the rainfall is most reliable and although the summer days are hot the relative humidity

remains high so that moisture losses by evaporation are less than elsewhere. The growing season is shorter than farther west but early summer rains permit the early planting of maize which gives a more certain return than elsewhere. Over most of the area the soils are of the Highveld Prairie type and are mainly sandy loams, cool and retentive of moisture, easy to cultivate and fairly fertile. Around Bethal intrazonal heavy black clayey loams of high fertility occur. The whole area supports sweetveld which affords excellent pasturage for both sheep and cattle. On most farms about one-third of the land is under cultivation and the remainder in grazing. Maize takes up nearly 70 per cent of the cropped land while teff for hay, oats, beans, and other fodder crops account for much of the rest. Green manuring is not practised but crop rotation is increasing although as yet there is no generally accepted system. Both cattle and sheep are kept and help to maintain the fertility of the land. Since 1937 the mechanization of agriculture has eliminated the need for trek-oxen and today the rearing and fattening of beef cattle dominates the livestock enterprises on most farms. Along the railway lines to Johannesburg, however, dairying takes pride of place. Sheep are less important than formerly, mainly because they fit less well into the economy. Generally speaking they increase in importance towards the Escarpment where conditions become less favourable for crops and the farms, generally larger, have more pasture. Along the railway lines near Delmas and Bethal there are a number of specialized potato farms. Here the light sandy soils are more suited to potatoes than maize while good rail facilities afford despatch to all the main markets of the Union. Pig farming is an important sideline on these farms. Generally speaking on most farms about 40 per cent of the cash income is derived from maize and nearly 60 per cent from cattle.

In the northern Free State heavy clay loam soils derived from dolerite, under conditions of low and unreliable rainfall do not produce good maize crops. They do, however, support sweetveld which remains palatable throughout the winter and yields good hay crops in summer. Hence more than 75 per cent of the farm land is in grazing. Maize is grown, mainly in the south where more sandy soils are associated with outcrops of Karoo sandstones. Stock enterprises contribute the main cash income but are followed closely by maize. Over most of the area the sale of wool and live stock brings the biggest returns but along the main railway from the Free State to Johannesburg the facilities for reaching the Rand market have encouraged highly specialized dairy farming and the production of fruit, vegetables, and poultry. It seems likely that such enterprises will increase with the growth of population accompanying the development of the Free State goldfields.

On the long disputed Caledon river lands along the Basutoland border the more evenly distributed rainfall and generally cooler conditions are responsible for a somewhat different agricultural economy from that found elsewhere in the Dryland Farming belt. In years with favourable autumn rains winter crops, particularly wheat, and to a lesser extent oats, can be grown but the acreage

fluctuates greatly and yields are low. Maize is equally important and although the growing season is short and early planting – before December – essential, the yield is more certain than that of wheat. Small acreages of rye, teff and cowpeas are also grown. Nearly one-half of the land is cultivated – a higher proportion than elsewhere. Of that left in grazing only about 65 per cent is sweetveld and the remainder, owing to the higher rainfall, is sourveld, which is usually burnt every year to provide summer grazing. Pasture is plentiful in summer, the maize stalks provide autumn feed, the young wheat is suitable for winter grazing for sheep and teff hay and maize silage supply winter feed for cattle. Shortages of feedstuffs are rare. On most farms both cattle and sheep are kept and the favourable conditions have enabled the farmers to concentrate on good quality animals. The dairying industry is well developed and there are many herds of Friesians and Brown Swiss. The breeding of pedigree cattle is also important. The sheep, mainly merinos, are also of high quality. Pigs are kept as a sideline on the dairy farms. On most farms wheat affords the main source of cash income and is followed by dairy produce and cattle sales. As a direct source of income maize is much less important than elsewhere, a much larger proportion of it being used for stock feed.

North-westwards from the Caledon river area the farming economy becomes transitional to that of the northern Free State. Wheat is still grown but becomes less important owing to its susceptibility to hail damage in early summer. Maize becomes increasingly important. Oats are more widely grown than elsewhere while teff, rye, beans, and cowpeas enter the rotation. Although crops receive most attention, stock farming is nevertheless important. Large numbers of sheep are kept mainly for wool, while good quality cattle are reared and both dairy produce and live stock sold. This area is centrally located on the Highveld and is the meeting place of the economies of the surrounding areas. As a result its agriculture is the most diversified, and the cash income is derived, in order of value, from maize, sheep, wheat, and cattle.

The north-western Free State with an annual rainfall around 20 inches is marginal for crop production. For long this area was one of large cattle farms supplying trek-oxen to the maize producers to the east. The coming of the railway encouraged crop production and during the 1920's maize production went ahead on the sandy soils which characterize the area. Farms decreased in size from an average of about 1,500 acres (700 morgen) in 1925 to about 1,000 acres (500 morgen) at the present time. With the decrease in farm size, the land use of necessity became more intensive and more mixed in character, processes hastened by the fall in maize prices during the depression years of the early 1930's and the danger of wind erosion on soils depleted by continuous cropping. During the past decade progress has been rapid and today the area is emerging as an important producer of beef as well as grain. This has been accompanied by an actual increase in the crop acreage and the introduction of fodder crops, for in winter the veld pasture is poor and affords little sustenance. Maize which formerly occupied more than 90 per cent of the arable acreage now accounts for only 60 per cent; grain remains

the main concern but an increasing proportion of it is used for fattening stock. Winter wheat, sown originally to protect the land from wind erosion, affords winter grazing, while ground-nuts, teff, cowpeas, and other fodder crops are grown. About half the farm income (compared with 70 per cent in 1937) is derived from the sale of maize, wheat brings in a further 14 per cent and ground-nuts 10 per cent, while the livestock enterprises contribute the remainder.

The western Transvaal is also marginal for crop production and today constitutes a problem area. At the beginning of the century it was mostly open veld given over to the rearing of merino sheep and cattle. Then phosphate deficiencies in the pastures caused enormous cattle losses and a sharp fall in wool prices made sheep no longer profitable. The farmers turned to grain farming. The land was cleared and cultivated continuously without fertilization until infested with quickgrass when a new portion was broken. In time all the land was taken and efforts were then made to eradicate the quickgrass by ploughing in winter. But soon the soil structure deteriorated and the strong north-westerly winds of August and September removed the loose material and built it up into dunes. Today the natural veld has been destroyed and quickgrass has taken its place. The farms are now too small for sheep runs. The arable acreage is still expanding and nearly 80 per cent of it is planted to maize. During the past decade ground-nuts, beans, and sunflower have been introduced. But there is a real need for conservation practices, the introduction of fodder crops and an increase in the livestock enterprises. Since phosphate deficiencies in the pastures can now be counteracted by feeding bonemeal the buying and fattening of store cattle from the adjacent ranching areas of the northern Cape could be developed and with the growth of population in the Klerksdorp and Orange Free State goldfields it may well be.

Mining and Manufacturing

The main centres of mining activity on the Highveld are the Witwatersrand, Klerksdorp, and Orange Free State goldfields and the Witbank, Vereeniging, and eastern Transvaal coalfields. Manufacturing industry is concentrated on the Witwatersrand and in the Vereeniging area. The Witbank coalfield, the main coalfield of South Africa, is remarkable for absence of industry, the individual mines with their characteristic headgears and tipheaps, doing little more than diversify an essentially rural landscape. Industries are growing up in the Orange Free State goldfield but as yet the character of the area is essentially ordered by mining activities. In the southern Transvaal the Vereeniging area is the centre of heavy industry, with the main Iscor iron and steel works at Vanderbijl Park, the Sasol oil-from-coal project near Coalbrook and a number of heavy engineering industries. The development of industry has gone hand in hand with the growth of mining. The major industries are in the hands of large concerns, some of them State controlled. Development has been comparatively recent. It has therefore been possible to plan the urban growth of the area and ensure the co-

ordinated development of industrial and residential zones and the provision of communications and amenities. This has been greatly facilitated by the level terrain of the area. The picture on the Witwatersrand is very different. There manufacturing activities have become superimposed on mining activities in a region of ridge and valley, population concentration and urban sprawl. As the main mining and manufacturing area in South Africa and the one great conurbation in which the most complex racial problems are experienced, however, the Witwatersrand although physically part of the Highveld, economically forms a distinct region and is considered separately in ch. 40.

The Kaap Plateau

Beyond the present limits of the cropping areas of the western Transvaal the country is more broken, particularly along the Orange river where erosive agents are cutting into the plateau, the climate is marked by increasing aridity, the soils become thin and are characterized by a layer of line accretion, 'ouklip', or diamondiferous gravel at shallow depth, and the vegetation changes to thornveld. Cattle rearing increases in importance and becomes the main concern on the Kaap plateau, where the farmers concentrate on milk for cheese production, an enterprise made possible by the coming of the railway to the Postmasburg manganese mines. The area carries very few people and the only centres are those connected with the mineral workings.

The Upper Karoo

South-westwards from the main cropping areas of the Free State the plateau surface becomes increasingly studded with flat-topped kopjes (Plates 119 and 120). With increasing aridity the soils become thinner, more sandy and alkaline, and the vegetation passes gradually to desert shrub. This is the Upper Karoo extending across the Highveld of the south-western Free State and southern Cape into the Cape Middleveld. It is a vast monotonous region in which every hill looks alike and only the bare patches of brilliant red soil between the scattered grey green shrubs lends colour to the scene. Sheep rearing is the sole occupation in the region. Since the carrying capacity of the veld is low the farms are large, varying in size from anything from 5,000 acres to 20,000 acres, and one may travel for hours without seeing any signs of life. The farmsteads are widely scattered. Usually they are betrayed only by their windpumps, drawing supplies of water from underground, and by the eucalyptus trees, planted to afford shade, which surround them and break the horizon. On the Highveld section merino sheep for wool production predominate but there is some fattening of lambs along the Riet river where fodder crops are grown under irrigation. Here too the production of seed potatoes has become important. This has been favoured by the relative freedom from disease associated with the hot, dry atmospheric conditions and with isolation from cropping areas. The Upper Karoo is crossed by the main railway line from Cape Town to Kimberley, Johannesburg, and Rhodesia, while at

De Aar lines branch to South West Africa and Port Elizabeth. This little 'dorp' has become a supply centre for the surrounding country while its nodality promises to attract industry to it. Recently the town has laid out an industrial site in the angle between the railways.

North-westwards into the Middleveld, with increasing heat and aridity, merino sheep give way to non-woolled blackhead Persian and cross-bred sheep and karakuls, which are better adapted to the conditions. In this area flood irrigation is practised along the watercourses, notably that of the Zak river, in favourable seasons. When the river comes down in flood the waters are diverted into shallow basins, known as 'saaidams' separated from one another by earthen banks. After the soil in these has been thoroughly soaked the water is allowed to pass to the next series of basins. Wheat is then sown in the moist ground and left to mature and ripen. The area sown fluctuates greatly from year to year according to the size of the flood, while yields are low. Most of the grain is sold and it seems regrettable that in this area which suffers from recurrent drought, such land is not used for fodder crops for the stock. Heavy stock losses might be averted in this way.

Beyond the Orange river the desert shrub gives way to thornveld which supports some cattle. This is a pioneering region, occupied only during the past fifteen years, engaged in rearing cattle for sale. It merges gradually into the Kalahari.

BIBLIOGRAPHY

1. J. H. WELLINGTON. 'Notes on the drainage of the western Free State Sandveld'. *S.A.G.J.*, Vol. XXVII, 1945, pp. 73–7.
2. J. H. WELLINGTON. 'The Lake Chrissie problem'. *S.A.G.J.*, Vol. XXV, 1943, pp. 50–64.
3. J. H. WELLINGTON. 'The Vaal–Limpopo watershed'. *S.A.G.J.*, Vol. XII, 1929, pp. 36–45.
4. See S. P. JACKSON. 'Climates of Southern Africa'. *S.A.G.J.*, Vol. XXXIII, 1951, pp. 17–37.
5. W. C. GIBBONS. 'Irrigation at Parys, Vaal river'. *S.A. Irrig. Mag.*, 1922.
6. Union of South Africa. Department of Agriculture, Division of Economics and Markets. *Agro-Economic Survey of the Union*, Dept Agric., Bull. No. 270, 1948.

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The Witwatersrand Conurbation[1]

The Witwatersrand conurbation (Plate 121) covers a belt of country extending over sixty miles from Randfontein in the west to Springs in the east and varying in width from five to twelve miles. Here there is a practically continuous spread of urban development although each of the original mining towns retains its identity (Fig. 218).

Geographically the Witwatersrand is particularly interesting for it possesses none of the advantages normally associated with the growth of great conurbations. It is located in the interior of a land mass, nearly 300 miles from the coast and over 400 miles from the nearest national port. It lies at an elevation of more than 5,500 feet, astride a major watershed – that between the Limpopo and Vaal – and is without local supplies of fuel or raw materials. Its growth has been due in the first place to the extent and long life of the Witwatersrand goldfield while its emergence as a major industrial centre is largely a response to the demands of the local market created by the mines. Today, lying midway between the iron and steel centres of Pretoria and Vereeniging, adjacent to the best farming belt in the country and at the centre of the communication system of southern Africa, it is exceptionally well placed for assembling raw materials and despatching finished products. In addition, located between the Witbank and Vereeniging coalfields and within forty miles of the Vaal river, it lies between what have become the major power pools of the country (see ch. 23, pp. 389–92) and within reach of the most favourable source of water. With every development has come the momentum for further development so that today the Witwatersrand bids fair to remain an important manufacturing and commercial region with gold mining playing a subsidiary and declining role.

The growth of the Witwatersrand conurbation has been phenomenal. Seventy years ago the area was virgin veld. In 1886 the development of its great goldfield began and during the next fifty years it grew to become one of the greatest mining areas of the world. Naturally it attracted a number of industries catering for the needs of the mines and the mining communities but until the late 1930's these were essentially of a service nature and the fundamental character of the region was ordered by mining activities. With the tremendous expansion in

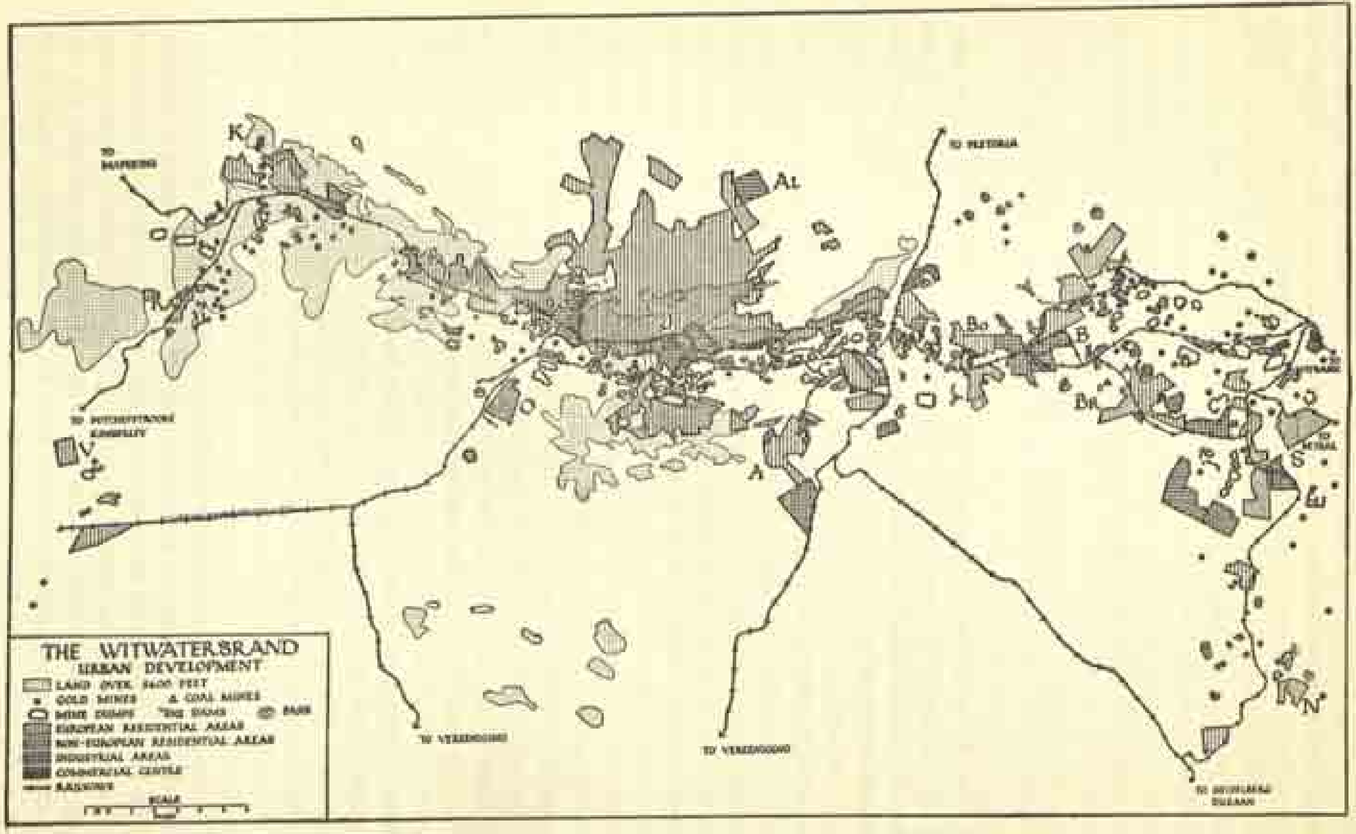


Fig. 218. The Witwatersrand; urban development.
(Courtesy *Transactions of the Institute of British Geographers.*)

manufacturing activities stimulated by the second world war, however, the Witwatersrand was transformed within ten years into the great industrial region of southern Africa. By 1950–1 it contained more than one-third of all the industrial establishments in the country and employed over 40 per cent of all the industrial workers. As this came about a new industrial pattern of development was rapidly superimposed on the old mining pattern while the very rapidity of the change and in particular the great increase in the urban population created economic and social problems of a complexity unknown in other industrial countries. In Johannesburg alone the African population doubled between 1936 and 1951 while the European population increased greatly. Comparable increases occurred in the other Rand towns. Small wonder then that this area has been the scene of some of the most difficult problems associated with race relations.

The actual pattern of urban development has been conditioned by the interplay of relief features, distribution of mining ground, access to railways and proximity to labour supplies. Marked contrasts distinguish the Central Rand from the East and West Rand.

The area occupied by the conurbation is one of varied relief. In the centre and west the Witwatersrand, rising some 500 to 1,000 feet above the general level, dominates the scene. Built largely of southward dipping conglomerates and quartzites of the Witwatersrand system, it presents a generally steep face to the north and slopes more gently southwards, but in the vicinity of Johannesburg the weathering of alternating quartzites and shales has produced a series of parallel rocky ridges and flat-floored valleys. To the east these rocks disappear beneath a cover of younger Karoo rocks and the country becomes open and relatively flat. North of the Witwatersrand is undulating granite country; to the south of Johannesburg resistant Ventersdorp lavas overlie the Witwatersrand rocks and form the high ground of the Klipriviersberg.

The location of mining activity has been governed by the disposition of the gold-bearing reefs but wherever possible advantage has been taken of the valleys in order to reduce shaft depths. Consequently in Johannesburg activities are restricted to the valley etched out by the headstreams of the Klip river whereas to the east and west they are more scattered. The residential areas occupy the higher ground while the industrial establishments have favoured intermediate locations with ready access to the railways which, originally built to serve the mines, follow the reef and take advantage whenever possible of valleys and natural gaps in the ridges.

There are, however, marked differences in the pattern of urban land use between the Central, East, and West Rand; and these in turn materially influence their problems. Industrial development is most advanced in the Central and East Rand, due to the fact that it has generally followed in the wake of mining activity in which these areas have held, in turn, dominant positions. On the Central Rand it is confined to a narrow belt following the railway north of the mining zone, on the East Rand it is dispersed in a number of industrial areas.

These differences result partly from the manner in which the areas have developed and partly from differing relief conditions. On the Central Rand industry was naturally attracted to the hub of mining activity but it came after the mining and residential areas had been established and was necessarily confined to the narrow valley zone. Development was unplanned. By contrast open level land abounds on the East Rand (Plate 123) where each municipality has sought to attract industry by laying out spacious well-equipped industrial sites. More recently the West Rand towns have followed suit.

Fig. 219. Johannesburg; urban development.
(Courtesy *Transactions of the Institute of British Geographers.*)

The Central Rand, which embraces Johannesburg, Germiston, and Roodepoort–Maraisburg, shows the greatest diversity of industry.

In Johannesburg the most important factory area (Figs. 219 and 220) follows the main railway line with newer offshoots on abandoned mining ground. Most of the industrial townships are small and hemmed in by mine dumps but more spacious ones occur at Industria, Heriotdale, Electron, and Steeledale. Some manufacturing industries extend into the commercial heart of the city.

The town possesses a considerable variety of industries with each tending to

Fig. 220. Johannesburg; the mining and industrial belt.
(Courtesy of the Institute of British Geographers.)

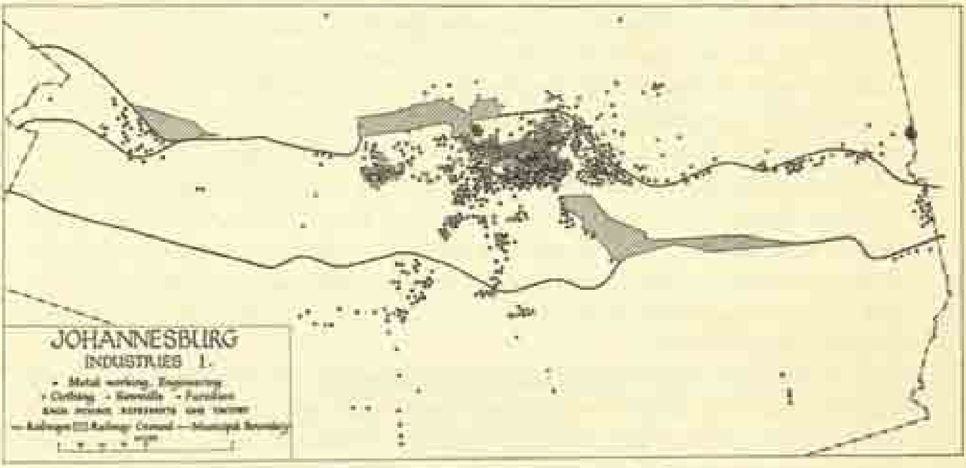


Fig. 221. Johannesburg; industries I.

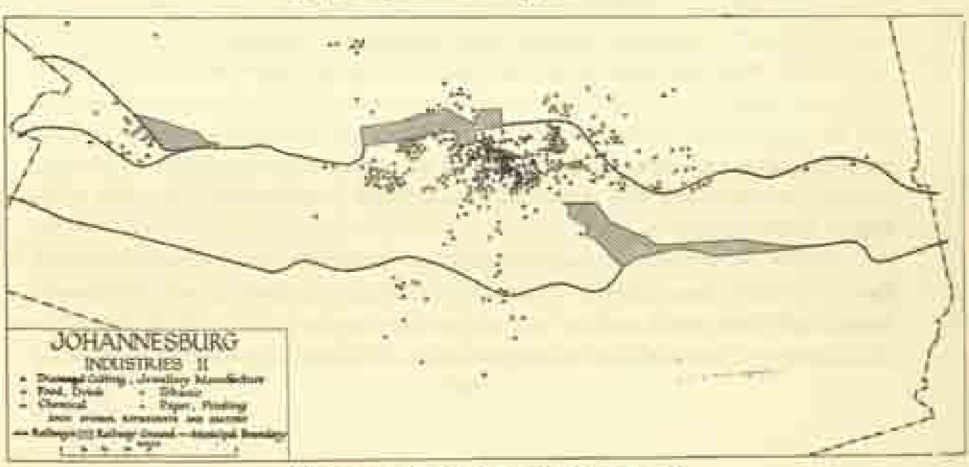


Fig. 222. Johannesburg; industries II.

concentrate in selected localities. Thus the sawmills, the metal-working and engineering industries (Fig. 221) occur along the railway and in the industrial townships created on old mining ground, the clothing factories and diamond-cutting works (Fig. 222) congregate in the commercial heart, furniture factories occupy intermediate locations, the cold stores and food processing establishments surround the abattoirs and the markets and grain mills are near the old station. For this the particular locational needs of the industries are responsible.

Thus the preference shown by the heavy engineering establishments, most of which make mining machinery, for the newer industrial areas in the railway zone results from the need for good rail facilities for the import of steel from the Iscor works at Pretoria and Vanderbijl Park and component parts from overseas. Originally many of these firms began in a small way making spare parts for imported mining machinery in the centre of the old town but when they took up the manufacture of heavy machinery during and after the war they moved out to more spacious sites along the railway in Denver, Jeppe, Industria, and Heriotdale where they were joined by newcomers, many of them offshoots of parent British and American firms. Today these factories employ several hundred workpeople, mainly unskilled or semi-skilled Africans. By contrast the light engineering trades, making small products of high value and employing mainly skilled European artisans have remained in the old centres.

The siting of the clothing factories has been influenced mainly by nearness to the market and to transport facilities for the workers, most of whom are women. Hence the concentration in the heart of the city which is the hub of the bus services and in Fordsburg near the poorer European residential areas and the Coloured suburbs. The desire to attract foreign visitors and overseas buyers has led to the concentration of the diamond-cutting works and jewellery factories in the commercial centre.

Today light industries are becoming increasingly localized in the centre of the city while the larger concerns and heavier industries are moving out. This raises the question of the area most suitable for future development. Here one must consider one of the most acute problems of Johannesburg – the unfortunate relationship between workplace and residence of Non-European workers which results from the isolation of their large townships – Alexandra and Orlando-(Fig. 223) from the main industrial belt. The railway provides transport in a west–east direction but facilities are inadequate and congestion acute. Likewise the bus services are inadequate. The journey to work is long and arduous and the resulting fatigue so lowers the efficiency of the workers and depresses output that some firms are moving to industrial sites outside Johannesburg in order to be nearer labour pools.

East of Johannesburg, Germiston has an industrial character transitional to that of the East Rand towns. With several clothing and food factories in the old centre and some metal working and engineering in the mining zone it resembles Johannesburg, but it differs in the possession of three well-equipped industrial

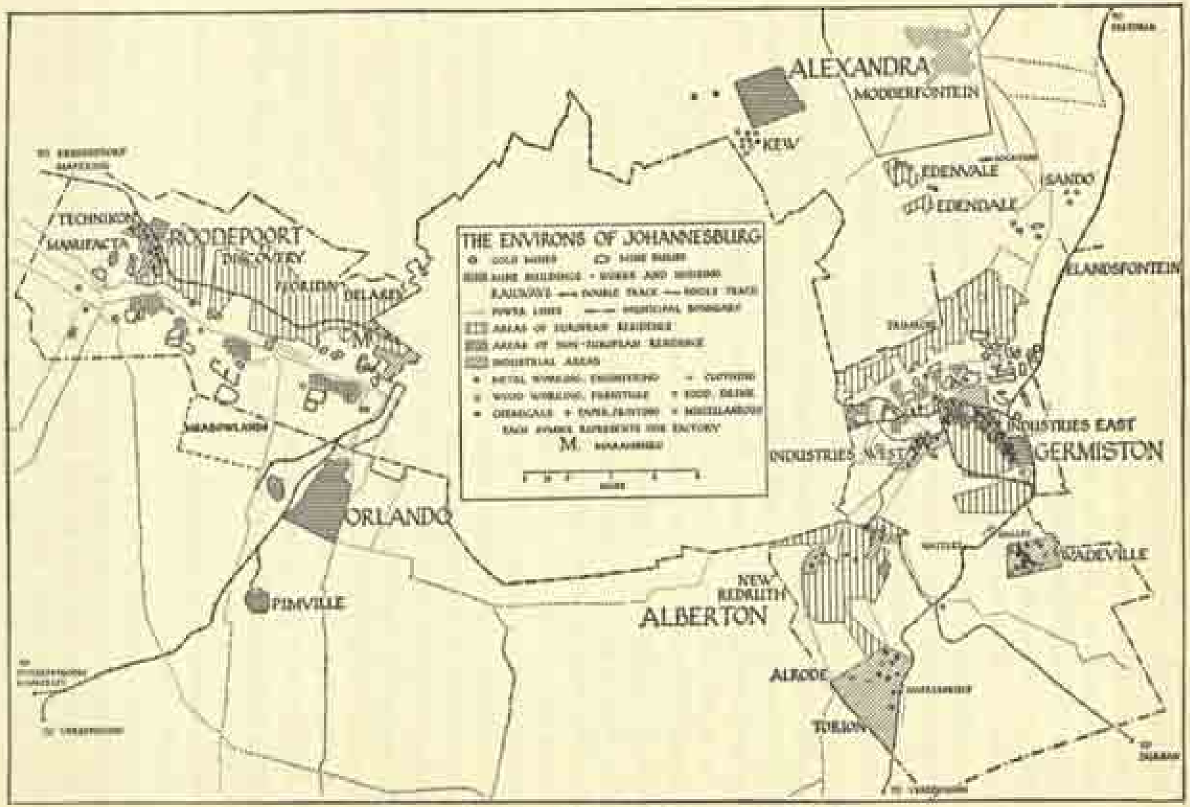


Fig. 223. The environs of Johannesburg; urban land use.
(Courtesy of the Institute of British Geographers.)

sites – Industries East, Industries West, and Wadeville – situated in open level country south of the mining belt. In this it resembles the East Rand towns. In the industrial areas heavy engineering attracted by cheap land, good rail facilities and access to labour (Fig. 223) predominates, but in Industries East direct rail connexions to the eastern Transvaal and Durban have led to the establishment of large chemical and food factories using molasses from Natal, maize from the eastern Highveld, coal from Witbank, and other raw materials from overseas.

Outside the municipal areas of Johannesburg and Germiston industries are being established along the Pretoria railway at Elandsfontein and Isando, along the Vereeniging railway and the Durban road at Alberton and along the Johannesburg–Pretoria road in Kew and Edenvale. Excellent rail and road facilities and abundant supplies of power and water have been the major attractions for industry in the two first-mentioned areas. Proximity to labour supply – in Alexandra township, which houses over 60,000 Africans – has been the main factor in the third, an area of intensive market gardening and poultry raising and one in which the conflict between agriculture and industry for the use of the land is serious.[8]

For future industrial expansion Germiston possesses ample suitable land within the municipal boundary south of Wadeville. Johannesburg is in a less happy position. There is little land in the old centre, while the municipal boundary abuts on excellent agricultural land on the north-east and north and on high ground in the south. The best opportunities occur in the west adjacent to Industria. This zone, in which mining is declining, is well served by railways and lies between large and growing Non-European townships on the south and areas of poorer European residence on the north.

West of Johannesburg industrial development is taking place in Roodepoort where the townships of Manufacta and Technikon have been created in the railway zone. Engineering is the main activity and among other factories there, the large Mazistalite works employs more than 5,000 people in the manufacture of light-weight building blocks.

Compared with the Central Rand, industrial growth on the East Rand is recent. For the most part it is confined to specially laid out industrial estates where heavy engineering predominates and as yet there is little diversification of activity (Fig. 224).

The opportunities for industrial development vary among the several towns. They are most limited in Brakpan where the mining zone straddles the railway in the north and agricultural holdings occupy the land in the south. Hence Brakpan remains essentially a mining town. Opportunities are great, however, in Springs which has excellent rail facilities and plenty of level land unfettered by mining activities or the regulations appertaining to agricultural holdings. The industrial townships of Nuffield and New Era, dating from the war period, are well placed both in relation to transport facilities and supplies of labour (Fig. 224). In both engineering predominates with the Hercules cycle works outstanding in the former and North British Locomotive Company and Metal Containers in the

latter. The preparation of mining timber, manufacture of furniture and processing of food are also important. The former industries have been encouraged by the availability of timber from the Drakensberg plantations, and the preparation of breakfast cereals and biscuits by the easy access to both the Transvaal maize area and the Natal sugar belt.

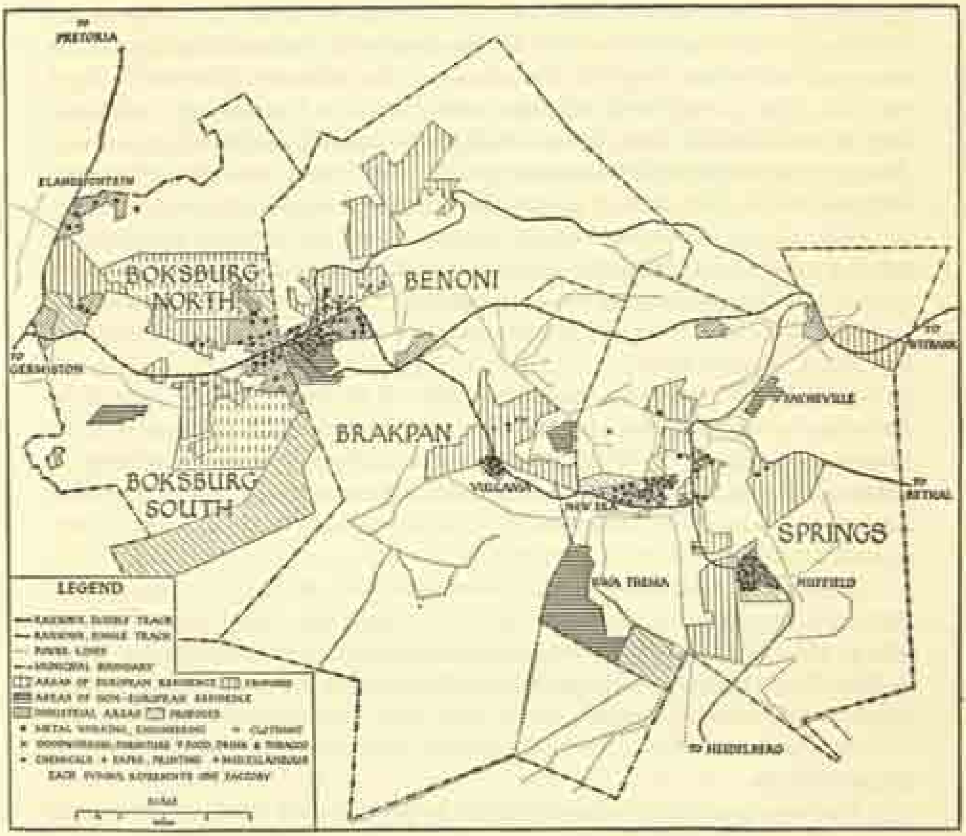


Fig. 224. The East Rand; urban land use.
(Courtesy of the Institute of British Geographers.)

From the industrial standpoint Boksburg and Benoni are fortunate in possessing land free from mining options in the railway zone. Here spacious sites and direct connexions to the Witbank and Ermelo coalfields led to the establishment of the Dunswart Iron and Steel Works on the Benoni side in 1911 and to that of the refining plant of the South African Torbanite Mining and Refining Co. (SATMAR) on the Boksburg side in 1934. Both in turn have attracted other industries, particularly heavy engineering and chemical concerns which utilize

their products. Further diversity came during the post-war period when spinning and weaving mills for working up the fibre of 'stokroos' were erected in Benoni.

Generally speaking the East Rand towns offer superior sites for industrial development and are particularly attractive to large concerns, but manufacturers requiring contact with a number of allied trades and serving the consumer market are likely to remain in Johannesburg.

As yet there is little industrial development on the West Rand. The area is farther removed from the sources of raw materials, whether these come from overseas via Durban, from the Union iron and steel centres or from the Witbank coalfield. Mining machinery and equipment is made in Krugersdorp and Randfontein has ambitious plans for industrial growth but with the development of the Free State goldfields and the expansion of the Vereeniging and Vanderbijl Park iron and steel centres, new developments are more likely farther south.

The growth of industry on the Witwatersrand has brought with it acute social problems. In particular the great influx of people into the towns has created a housing problem of the first magnitude especially in respect of Africans (see Plate 124). This problem has been aggravated by the conflict between mining and manufacturing interests for a labour supply and by the fact that it arose during the war and post-war years when there was neither material nor labour for domestic building. In mines and industry alike the shortage of labour was acute. Whereas the mines provided accommodation both for their European employees engaged on a permanent basis and their African workers employed on a short-term basis, the manufacturing concerns, with few exceptions, did not provide any accommodation but attracted labour by higher wages and better working hours. The burden was thus thrown on the local authorities while the mines, already heavily burdened with taxation, looked with disfavour on anything likely to benefit industry. Thus the problem reached enormous proportions before it was tackled. The old Native townships became overcrowded and shanty towns became characteristic adjuncts to them. At the same time inadequate transport facilities between home and place of work caused acute congestion and wearisome travelling conditions.

The size and gravity of the problem naturally varied between the several towns. On the East Rand the provision of housing formed part of the general plan for industrial development and new Non-European townships were created adjacent to the industrial townships. Few difficulties were experienced. In Johannesburg, on the other hand, the position became so serious that the Government Native Affairs Department stepped in with a plan for clearing the existing slums and re-housing the people in decent houses in spacious surroundings; and at the same time reducing the scatter of native locations and concentrating Non-European settlement in a small number of areas from which adequate transport facilities to the manufacturing belts could be readily provided. According to this plan Alexandra and Eastern Native townships are to remain to serve the northern part of the city and the eastern industrial belt but with a reduction

of their population in accordance with the carrying capacity of the stands. Western Native townships and the eleven areas of squatters camps are to be cleared and the people re-housed in new townships adjacent to Orlando – i.e. near the zone of active industrial expansion and within reach of the main line railway. The transfer of Africans from Western Native townships to Meadowlands, which has aroused so much controversy, forms part of this scheme.

In order to finance the provision of the necessary houses and transport facilities for industrial workers the Government has imposed an Industrial Levy which obliges every employer of Non-European labour to contribute an annual payment of one shilling per employee to a central fund.

The relocation of the Bantu residential areas on the Witwatersrand is a practical expression of the South African Government's policy of racial 'Apartheid'. At the same time it represents a bold attempt at tackling an acute social problem and provides an interesting example of urban land use planning designed to ensure reasonable living conditions and an easy journey to work for all workers.

BIBLIOGRAPHY

1. See MONICA M. COLE. 'The Witwatersrand conurbation: a watershed mining and industrial region'. *Trans. I.B.G.*, No. 23, 1957, pp. 249–65.
2. See MONICA M. COLE. 'The Bedford View – Edenvale area; a land utilization survey'. *S.A. J. Sc.*, Vol. XLVIII, 1952, pp. 339–42.

41

Basutoland

The British Protectorate of Basutoland is a poor mountainous country in which the inhospitable nature of the terrain and the pressure of an increasing population dependent on the land have led to certain modifications in the traditional Bantu economy (see ch. 34) and through overgrazing and the cultivation of very steep slopes to some of the worst erosion anywhere on the African continent.

The country is divisible into two distinct regions – the sandstone or lowland Basutoland in the west, actually over 5,000 feet high and the volcanic or upland Basutoland in the east rising to over 10,000 feet. The former is characterized by a series of terrace-like platforms bounded by rocky escarpments; it is frequently deficient in surface water and the springs are liable to fail in the dry season; its soils are light and sandy. The volcanic rocks make up the greater part of the country. They give rise to a maturely dissected plateau, characterized by long, steep, grassy slopes and well supplied with springs and brooks; the volcanic rocks weather to black fertile soils which, although difficult to work, are capable of producing good crops of wheat.

The Lowlands formed the cradle for the Basuto nation. To the north and east the Highlands, bounded by the virtually impregnable wall of the Drakensberg towering above the eastern coastal belt, provided security against Zulu attack. Within the Lowlands the rocky westward facing escarpments, ranging up to several hundred feet, enabled settlements established on the terrace-like platforms above to be relatively easily defended against Boer attack from what is now the Orange Free State. It was on such sites that the settlements grew up, the huts occupying hillsides or rock ledges overlooking the cultivable land of the valleys and well placed for warning of enemy attack. The villages occupy similar sites today. Although partly a legacy of the past the choice of such sites offers several advantages. 'The huts do not occupy the fertile soil of the valleys; they receive more sunshine and avoid cold air drainage at night'; and they overlook the lands so that 'from his hut door a man can see that his neighbour's cattle are not straying into his crops or that his wives are going on properly with their work in the fields'.[1] In most cases the huts are built either of mud, which in some cases is

made into sun-dried bricks, or of stone and are thatched with reeds and tambootie grass (Plates 126 and 130). They are more substantial than those of other Bantu tribes and today, partly as a result of European influence there is a tendency to prefer the rectangular to the round form.

At the beginning of the century settlement and cultivation were almost entirely confined to the Lowlands and the Highlands were used only for summer pasturage. With the increase in the population during the past fifty years, however, much Highland pasturage has been broken by the plough (see Plate 130). There has in fact been a general migration to the mountains where the population has tended to concentrate on a clearly defined peneplain at 7,500 feet. In places cultivation has been carried up to 8,000 feet, above which the climate is too bleak for crop production. Both in the Lowlands and the mountains the cultivated lands occur mainly in the valleys and on the lower and gentler slopes of the hills, but owing to the increasing population pressure and the dearth of land many families have ploughed the steep slopes and thereby initiated severe gulley erosion.

In the old days most of the stock were kept at the village but surplus animals and cattle brought back from raids were kept at distant cattle posts hidden away in remote gorges in the mountains.[2] With the growth of population, however, all the available land in the Lowlands has had to be used for arable crops and today the people have perforce to keep their stock at the cattle posts. Such is the pressure on the land that even in the Highlands already many people have to keep their stock at cattle posts rather than at the village. Most of these cattle posts lie in bleak and inaccessible country above 8,000 feet (see Plate 129). In some ways they resemble the alpine pastures of Europe and the Basutos do in fact practise a kind of transhumance. At the cattle posts the herd boys live in rude huts of undressed stone roofed with thatch. Occasionally rough stone kraals are provided for the stock but more usually the animals have to find shelter from the bitter winds in the lee of some rock or ridge. The posts are connected with one another and with the villages only by rough winding paths. The stock spend the greater part of the year at the cattle posts, coming down to the villages only after the harvest when the arable lands are thrown open for grazing. The animals cannot remain long, however, for the grazing does not last for more than a month or two and no fodder is grown. The grazing exhausted, the cattle return to the posts as soon as the mountain passes are open and the first spring rains have fallen. The oxen required for ploughing, however, remain behind and sometimes if there is sufficient grazing a few milch cows as well. Thereafter until January or February there is a constant movement of animals to and from the cattle posts; as the grazing deteriorates the cows return to the mountains; exhausted oxen are sent back and new ones brought down and finally at the end of the ploughing season, with the exception of a few animals retained to thresh the wheat, all the oxen are sent back. This enforced areal separation of the stock and crop facets of the Basuto economy constitutes the major point of divergence from the traditional economy as still practised in the Union.

Mainly because of the climatic range induced by great differences of altitude, a greater variety of crops are grown by the Basuto than by other Bantu peoples and in particular wheat is a major crop. The most important crops are maize, kaffir corn, and wheat, but sweet cane, peas, beans, oats, and barley are also grown. Because of the shortness of the season kaffir corn is hardly grown in the Highlands, however, where wheat, barley, beans, and peas are more widely grown than elsewhere. In the Lowlands wheat is grown as a winter crop, maize and kaffir corn are the summer crops. In the Highlands both wheat and maize are summer crops. In both areas the fields are usually divided between two crops, wheat, peas, or beans being grown in one part and maize or kaffir corn mixed with pumpkins, squashes, gourds or sweet cane in the other. Practically all the maize and kaffir corn produced in the country is consumed there but between one-third and one-half of the wheat crop is normally exported to the Union where its good milling and baking qualities and high gluten content are appreciated. Every year it is necessary to import some maize and kaffir corn but on balance, except in years of bad harvests and in spite of low crop yields, Basutoland has an exportable surplus of grain. In this it contrasts with the other Bantu territories. Generally speaking arable cultivation is more highly regarded by the Basuto than by other Bantu groups and in some ways is more advanced. Ploughs are almost universally used and planters are more common than among other Bantu peoples. In the valleys some irrigation is practised. But in other directions the agriculture remains primitive. Kaffir corn and maize are threshed with sticks or knobkerries, the wheat, peas, and beans usually by 'treading out' by horses.

Twenty years ago the very existence of Basutoland was threatened by accelerating erosion. In 1935, however, following the report of the Commission appointed to inquire into the financial and economic position of Basutoland, a sum of £160,000 was made available by Great Britain for soil conservation and the teaching of improved agricultural methods. Following the passing of the Colonial Development and Welfare Act of 1945, Basutoland was allocated £830,000 for an approved ten-year development plan, one-third of the money being earmarked for agriculture and especially conservation measures. These monies have been used for contour terracing (see Plate 131), the building of small earth dams to check erosion and at the same time provide water for stock, for the planting of trees to protect the land and at the same time provide firewood and thereby reduce the use of manure for fuel (see Plate 127), and for educating the Bantu as agricultural demonstrators. Since the war considerable progress has been made. By 1948 over 227,000 acres of densely populated lowland had been terraced and in the mountains 203,000 acres had been protected by grass buffer strips. About 260 earth dams had been constructed.[3] After years of propaganda, demonstration and latterly of practical help through Government loans for Scotch carts for carrying manure, the people are beginning to fertilize their lands, but crop yields remain low, only 1·5 bags of maize and 1·8 bags of kaffir corn usually being obtained. On manured lands, however, average yields of 5·7 bags of

maize and 6·7 bags of kaffir corn have been obtained and with skilled farming higher ones are possible. Following the serious deterioration in the pastures, severe erosion and heavy cattle losses which followed overstocking and over-grazing and the severe droughts of 1930 and 1931, some success has been achieved in reaching a balance between the numbers of stock and the carrying capacity of the veld. Grazing control has been introduced and is now enforced by some chiefs. As a result of the Government's policy of introducing high-grade animals, the culling of inferior stock, the acceptance of selective breeding and the eradication of scab, improvements have been effected in the quality of sheep, goats and horses, all of which are of direct economic value and often produce a cash return, i.e. from wool, mohair, etc. Little improvement, however, has been achieved in the case of cattle, which are prized more for their social than for their economic value.

While considerable success has been achieved with soil conservation, the essential problem of Basutoland – too many people and too little productive land – remains. The country lacks mineral resources[4] or opportunities for industrial development. Vehicular roads are few and found only in the western Lowland. Although mountain roads are now being built, in the more rugged and inaccessible areas the famous Basutoland ponies following narrow bridle paths must long remain the main mode of transport. In face of limited opportunities for economic advancement,[5] the natural increase of the population is great. Every year about 200,000 Basutos are away working in the mines and factories of the Union. Labour is and will probably continue to be the main export of Basutoland whose economic existence is inevitably linked with that of the Union.

BIBLIOGRAPHY

1. R. U. SAYCE. 'An ethno-geographical essay on Basutoland'. *G.T.*, Vol. XII, 1924.
2. HUGH ASHTON. *The Basuto.* O.U.P. 1952.
3. G. FITZGERALD-LEE. 'Basutoland's success with soil conservation'. *New Commonwealth*, April, 1951.
4. See G. M. STOCKLEY. *Geological Survey of Basutoland.* London. 1949.
5. See also R. R. STAPLES and W. K. HUDSON. *An Ecological Survey of the Mountain Area of Basutoland.* London. 1938.

42

The Transvaal Plateau Basin

This region contrasts with the Highveld by virtue of its lower elevation, warmer climate, distinctive vegetative cover and less advanced economic development. It is, however, a complex region in which geomorphological processes acting on differing geological structures and rocks of varying resistance have produced the characteristic surface features which distinguish its three major sub-regions – the Bushveld Basin in the centre, the Bankeveld surrounding it and the Palala, Soutpansberg, and Pietersburg plateaux to the north. The first mentioned is a remarkably level basin approximately coinciding with the Bushveld Igneous Complex, the Bankeveld comprises a series of ridges and valleys corresponding with the inward dipping Transvaal rocks, the Palala and Soutpansberg plateaux are level uplands developed over nearly horizontal Waterberg sandstones and the Pietersburg plateau is a peneplain cut across the Old Granite (Fig. 225).

The relationship of the sub-regions to one another is best appreciated in the light of their geomorphological evolution. Here the main features of the drainage first command attention.

The whole of the Transvaal Plateau Basin is drained by streams flowing to the Limpopo but the drainage pattern bears little relationship to the present surface features or to the underlying structure. The trunk rivers rise on the Highveld, enter the Bushveld Basin via narrow gorges cut in the surrounding Bankeveld, maintain with difficulty their flow across the central basin which they leave in further gorges through the highland rim and some of them finally trench the northern plateaux in order to reach the Limpopo.

It is probable that the Loskop and Waterberg sandstones once covered the central Bushveld Basin linking up the present outcrops in the northern plateaux with those south of Loskop Dam, but that they were removed in Middle Palaeozoic times and the norite and granite, thereby exposed. These were fashioned by ice movement during the Dwyka glacial period. Subsequently much of the area was buried beneath Karoo sediments and lavas. The evidence suggests that the present drainage was initiated on this Karoo cover (see ch. 1, p. 15) which sloped downwards towards the north and east. Hence from the west and centre of

the present Bushveld Basin the rivers drained northwards and from the east, they flowed north-eastwards and eastwards towards the Limpopo. As erosion proceeded the Karoo cover was stripped from much of the area and the rivers became superimposed on the ancient rocks below. This process was much affected by the Tertiary warpings which arched up the Witwatersrand and Soutpansberg and by the persistent sagging of the Bushveld Basin. The Olifants and Crocodile

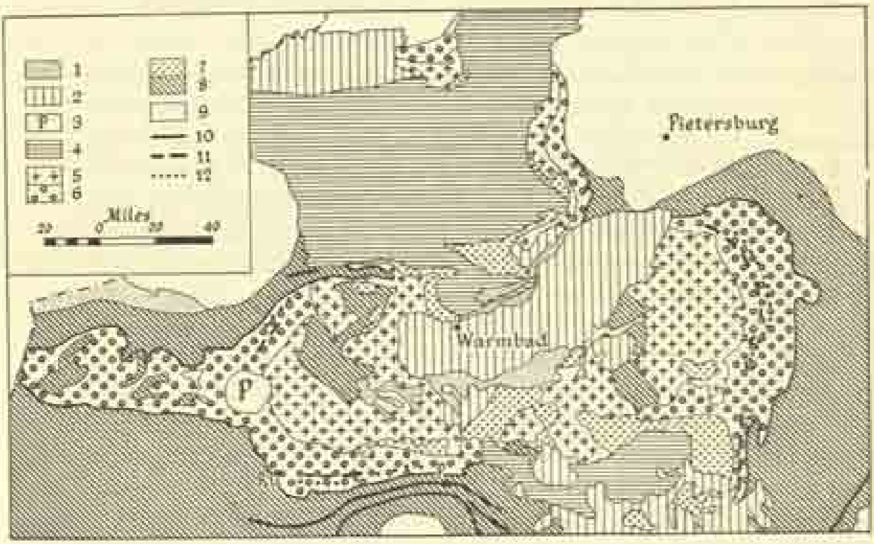


Fig. 225. The Transvaal Plateau Basin; geology and drainage.

1. Superficial deposits of Tertiary to Recent age. 2. Rocks of the Karoo System; mainly lavas and sandstones of Stormberg age on the Springbok Flats; shales and coal measures in the Waterberg coalfield. 3. Alkaline eruptive rocks of the Pilansberg. 4. Sandstones etc. of the Waterberg System. 5. Red Granite of the Bushveld Igneous Complex. 6. Norite of the Bushveld Igneous Complex. 7. Felsites and granophyres of the Rooiberg Series forming the 'roof' to the Bushveld Igneous Complex. 8. Rocks of the Transvaal System forming the 'floor' to the Bushveld Igneous Complex. 9. The Old Granite and rocks of the Primitive Systems. 10. Iron ore horizons. 11. Chrome ore horizons. 12. Merensky reef.

(Geology after the Union Geological Survey.)

rivers were able to maintain their courses through the axes of uplift, where the process of superimposition was accelerated, but the flow of some of the smaller streams was reversed and that of the Nyl barely maintained across the central subsiding area. As the processes of drainage superimposition proceeded so the agents of weathering and erosion resurrected ancient landscapes in some areas and cut extensive peneplains in others, thereby producing the distinct subregions of the present Transvaal Plateau Basin.

The Bankeveld

The ridges and valleys of the Bankeveld show all the features of recent resurrection and differential erosion. Composed of rocks of the Pretoria series, they form a girdle around the Bushveld basin interrupted only in the south-east, where the Karoo cover is preserved, and in the north, where to the west of Potgietersrust a tongue of igneous material extends northwards. The ridges and valleys are best developed in the south-west and east. In the former area the stages in the superimposition of the drainage from a Karoo cover have been studied by J. H. Wellington.[1, 2] Here the main drainage lines on the Karoo cover are northwards and accordant with structure and surface. East of Delmas small rocky exposures of quartzite protruding through the Karoo cover indicate the first stage of the resurrection of an ancient landscape. Westwards from this point the outcrop widens and gradually east–west trending ridges and valleys are discernible, becoming more clearly defined and more acute with increasing distance from the Karoo cover. At the same time the main northward flowing rivers superimposed on the older surface cross the ridges in transverse valleys which become progressively deeper and more gorge-like towards the west (see Plate 132). The ridges are all built of quartzite and present steep escarpments to the south and slightly gentler dip slopes to the north. They are named the Magaliesberg, the Daspoort, and Timeball Hill ranges (Fig. 226). The first-mentioned forms the most marked feature, attaining an average elevation of 5,000 feet and reaching over 6,000 feet west of Rustenburg. After a gap, which is not represented in the other ranges, the Enzelberg continues the line of the Magaliesberg until the outcrop swings round and assumes a north-easterly trend in the Dwarsberg and Gatkop ridge. Between the ridges well-marked longitudinal valleys have been etched in the softer shales and diabase. These valleys are occupied by subsequent streams which provide water for irrigation purposes. Where the main rivers negotiate the ridges, their deep gorges afford dam sites, while the clay vales provide suitable conditions for the lakes created by impounding the water. A series of such dams (Plate 132) have been constructed (see ch. 7, pp. 137–8), and supply irrigation water to farms in the Bushveld Basin.

In the eastern Transvaal and Sekukuniland the girdle of high ground covers a wider area. Here too there is a parallel series of ridges and valleys, in this case trending north/south. However, apart from the Steenkampsberge (of Magaliesberg quartzite), which rises to 7,000 feet and the Tokane maintains (of Daspoort quartzite), the quartzites of the Pretoria series do not produce sharply defined features. Far more striking are the norite ridge of the Lulu mountains (Plate 133) to the west and the ridge of dolerite and Black Reef quartzite to the east. The latter builds the Great Escarpment before swinging westwards to form the Strydpoort range which marks the northern limit of the Bushveld basin. In this eastern section the Olifants and Steelpoort rivers cut through the ridges in deep poorts. In the south a number of broad subsequent valleys carrying perennial

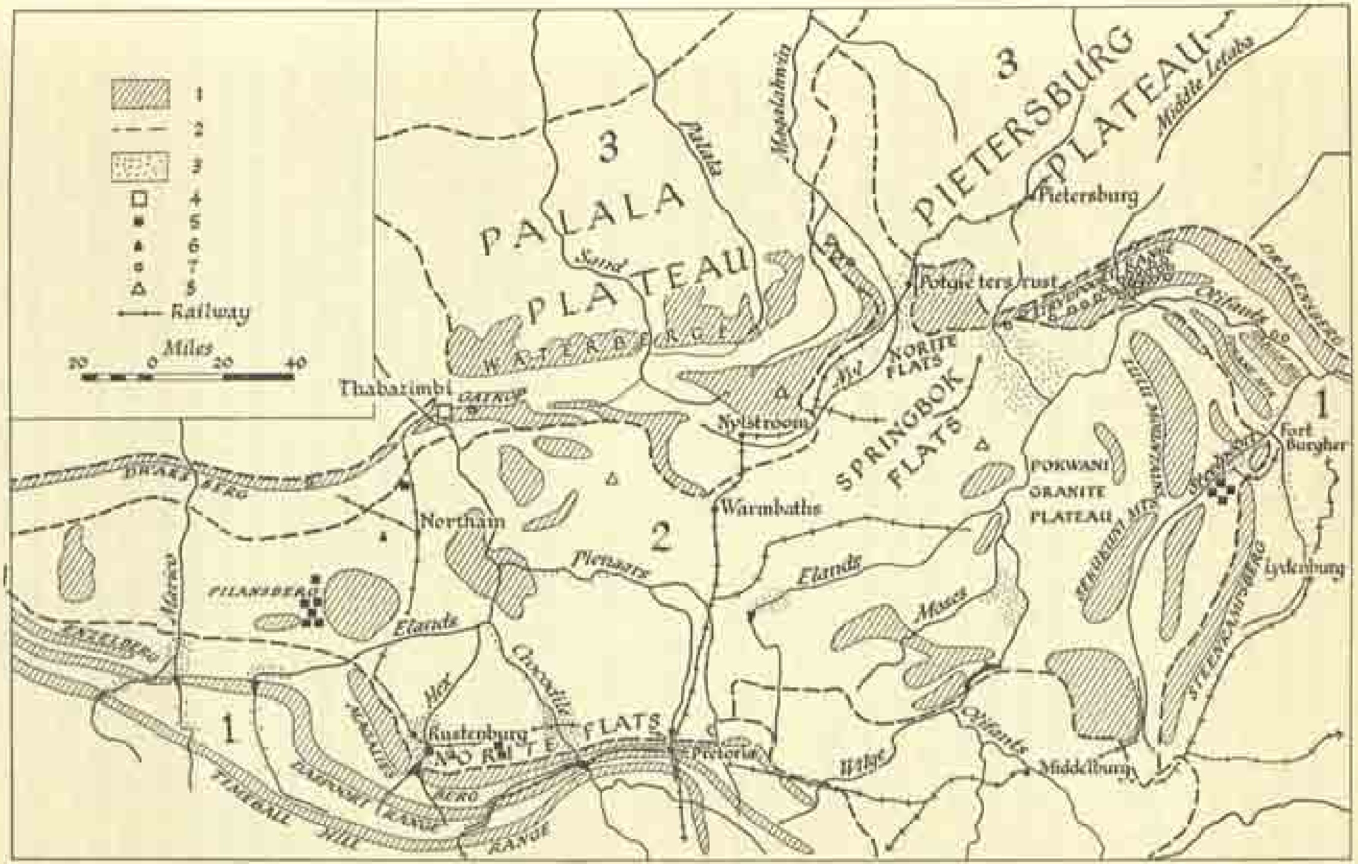


Fig. 226. The Transvaal Plateau Basin; topography.

1. Prominent orographical features. *2*. Regional boundaries: 1. Bankeveld; 2. Bushveld Basin; 3. Northern Plateaux. *3*. Areas of intensive irrigation farming. *4*. Iron ore mines. *5*. Chrome ore mines. *6*. Platinum mines. *7*. Asbestos mines. *8*. Tin. *9*. Railways.

Numbers in Italic refer to the key

streams, notably the Spekboom and Waterval, have developed but in the north the country is waterless, and the rivers draining to the Olifants and Steelpoort are dry for the greater part of the year.

The opportunities for agriculture in the Bankeveld are limited to the longitudinal valleys, for the ridges are steep and covered only with very thin stony soils. The valleys are protected. The summers are excessively hot, especially in Sekukuniland, the winters are warm. Rainfall is everywhere deficient and agriculture is dependent on irrigation. Proximity to the Witwatersrand and Pretoria markets has encouraged dairying and truck farming in the valleys west of Pretoria, while some winter wheat and tobacco is grown. Sekukuniland is isolated. The waterless tracts north of the Steelpoort river are in Native ownership and European farms are found only along the Steelpoort, Spekboom, and Waterval rivers. Here winter wheat and tobacco are grown under irrigation on the alluvial valley lands (Plate 134) while large numbers of cattle are kept. The Natives are mainly cattle rearers but cultivate Kaffir corn or mabela (Plate 137) for porridge and beer, the crops often being grown on partially cleared land in which the larger trees remain upstanding.

Economically of greater significance is the mineral wealth of this region, the most important iron ore deposits of the Union occurring in the Dolomite at Thabazimbi and further important reserves in the Timeball Hill quartzite which, at present, are quarried at Pretoria, where they have led to the establishment of the Iscor iron and steel plant. Asbestos deposits, found in the Pretoria series along the Olifants river, are worked at Penge. Both Thabazimbi and Penge are isolated mining settlements which apart from providing work for large numbers of Natives exert little influence on the surrounding country.

The Bankeveld contains one major town – Pretoria, the seat of the Union Government, founded in 1855 when the South African Republic chose the site for their new capital, more centrally located than the existing one at Potchefstroom. The modern town has grown up in the shale vale between the Timball Hill and Daspoort ranges. A number of geographical factors led the Boers to choose this site in preference to one on the Highveld for their capital. In the first place the vale, protected from cold southerly influences, enjoys warmer winters than the Highveld, an important factor in the last century when wood was scarce and coal unknown in South Africa. Secondly it commands the main routeway to the north, where the Aapies river cuts through the quartzite ridges; at the same time it controls east–west movement between the ranges. Lastly, and most important, an excellent supply of water was available from the springs issuing from the Dolomite in the Fountains Valley to the immediate south.

Today Pretoria is essentially an administrative centre, with the Union buildings majestically perched up on the Daspoort range and commanding extensive views southwards. At one time local supplies of iron ore and the establishment of the Iscor iron and steel works threatened to turn it into an industrial town. The centre of industrial activity, however, has now shifted

southwards and apart from its railway workshops, small engineering, leather and textile works, the wheels of manufacture do not disturb the quiet and pleasant town, famed for its wide streets lined with jacaranda trees. Nevertheless, the population has nearly trebled since 1921. The old centre has of necessity had to spread in an east-west direction while new townships have jumped the quartzite ridge and grown up at Hercules and Pretoria North. The very nature of the steep ridge prevents the growth of an agglomeration here and the old centre maintains its individuality.

The Bushveld Basin

This vast region extends over 250 miles from west to east and 80 miles from north to south and lies at an average elevation of between 3,000 and 4,000 feet above sea-level. For the most part the surface is monotonously level and covered with a growth of tall grasses and low Acacia trees and bushes (see Plate 139), but here and there hills of inselberg type break the horizon. Best known are the Pyramids, and Zwartkoppies north and north-west from Pretoria. In Sekukuniland,[3] in the east, however, the country is very broken for the norite has suffered rifting parallel to the dip of its floor, which has produced a series of homoclinal ridges, the most striking of which builds the Lulu mountains (Plate 133), which attain an average elevation of 5,000 feet and rise some 2,000 feet above the surrounding country. Elsewhere minor relief forms are due to the nature of the underlying rocks, the remnants of the Rooiberg roof of the lopolith and unconsumed rocks of the Transvaal system within the igneous mass both giving rise to well-marked features. Thus a thin capping of Rooiberg quartzite over the Red Granite is largely responsible for the escarpment of Sekukunis mountains overlooking the Steelpoort valley and norite country in the east; the felsite forms prominent ridges around the Waterberg plateau north of Loskop dam and again west of Warmbaths as well as stretches of rolling country standing above the general level of the basin north-east of Pretoria; broad piles of granophyre rising to more than 6,000 feet surmount the Pokwani plateau west of Sekukunis mountains. The quartzites and dolomite of Transvaal age caught up in the igneous mass give rise to the Ramakoks hills at the junction of the Crocodile and Pienaars rivers and the high ground around Marble Hall. Of a special nature are the mountain mass of the Pilansberg – a volcanic plug – and the circular ridge of the Pretoria soda caldera (Plate 140). In contrast to this broken high ground, the horizontally disposed deposits of Karoo age produce the exceptionally level area of the Springbok Flats. Here the Ecca shales and coal measures outcrop around the rim and are succeeded in turn towards the centre by the later sandstones and basaltic lavas of Stormberg age. The sandstone gives rise to broad swelling sandy bults from which rise steep-sided kopjes of tumbled sandstone 'masonry'. The lava forms the extremely level areas of the Northern and Southern Flats which are separated by a sandstone divide.

Away from the main rivers the country is poorly watered. Few streams rise within the Bushveld Basin and they are dry for the greater part of the year. The

Springbok Flats are practically devoid of any surface drainage. In the west the Nyl river occupies an ill-defined channel and meanders through a broad grassy vlei which is nearly two miles wide near Naboomspruit. Several streams rising on the high ground to the west empty into this but most of the water disappears underground. Towards the end of the summer rainy season the greater part of the vlei becomes a marsh, which gradually dries up during the dry winter. In the east a number of streams, notably the Zebediela and Gompies, drain from the Strydpoort range but most of them disappear into the porous sandstones rimming the Flats before reaching the Olifants river. Elsewhere there is no surface drainage. The basin-like structure of the region, however, does favour the accumulation of abundant supplies of underground water; this may be tapped at depths of from 20 feet to 80 feet and wind-pumps turned by the strong winds which sweep across the flat country characterize every farm.

The climate is distinctly warmer than that of the Highveld plateau country to the south (Fig. 227). The Magaliesberg effectively shuts out southerly influences and spells of severe cold such as occasionally strike the high plateau in winter are not experienced. Below 3,500 feet severe frosts are rare, but mild ones are frequent in the flat areas. Summers are hot with temperatures rising to above 80° F. on most days and exceeding 90° F. on occasions. The rainfall is normally below 30 inches. Except where irrigation water is available, this combination limits crop production to the more drought-resistant plants.

Soils and vegetation also exert an important influence on agricultural activities. They bear a close relationship to the underlying geology. Black turf soils, rich in potash and available phosphates, overlie the basalt in the Springbok Flats and also the norite in the level country near Rustenburg. Red heavy loams, somewhat poorer in phosphoric oxide, occur where there is some admixture of sand in the parent material and red sandy loams and grey sandy soils, poor in plant nutrients, overlie the sandstone and granite; dark grey clay loams are found in the vleis. The black turf soils, although difficult to cultivate, offer the best opportunities for field crops, while the lighter loams are favourable for fruit trees. The sandy soils are of little value.

After rainfall in summer the water drains rapidly through the sandy soils but the absence of run-off and the impervious nature of the black turf and heavy loams result in their being saturated for a week or more at a time. Throughout the dry winters all the soils are deficient in moisture. Within the limits set by climate the character of the soils and especially their internal drainage conditions largely determine the nature of the vegetation although repeated veld burning has also played its part. On the Springbok Flats where light frosts may be experienced in winter and where the black turf and heavy loam soils are subject to alternate waterlogging and drought the vegetation is characteristically grassland. By contrast the higher better-drained surrounding country with its sandy soils carries a scrubby growth characterized by *Acacia* spp. and in parts of Sekukuniland by *Euphorbia candelabra*.

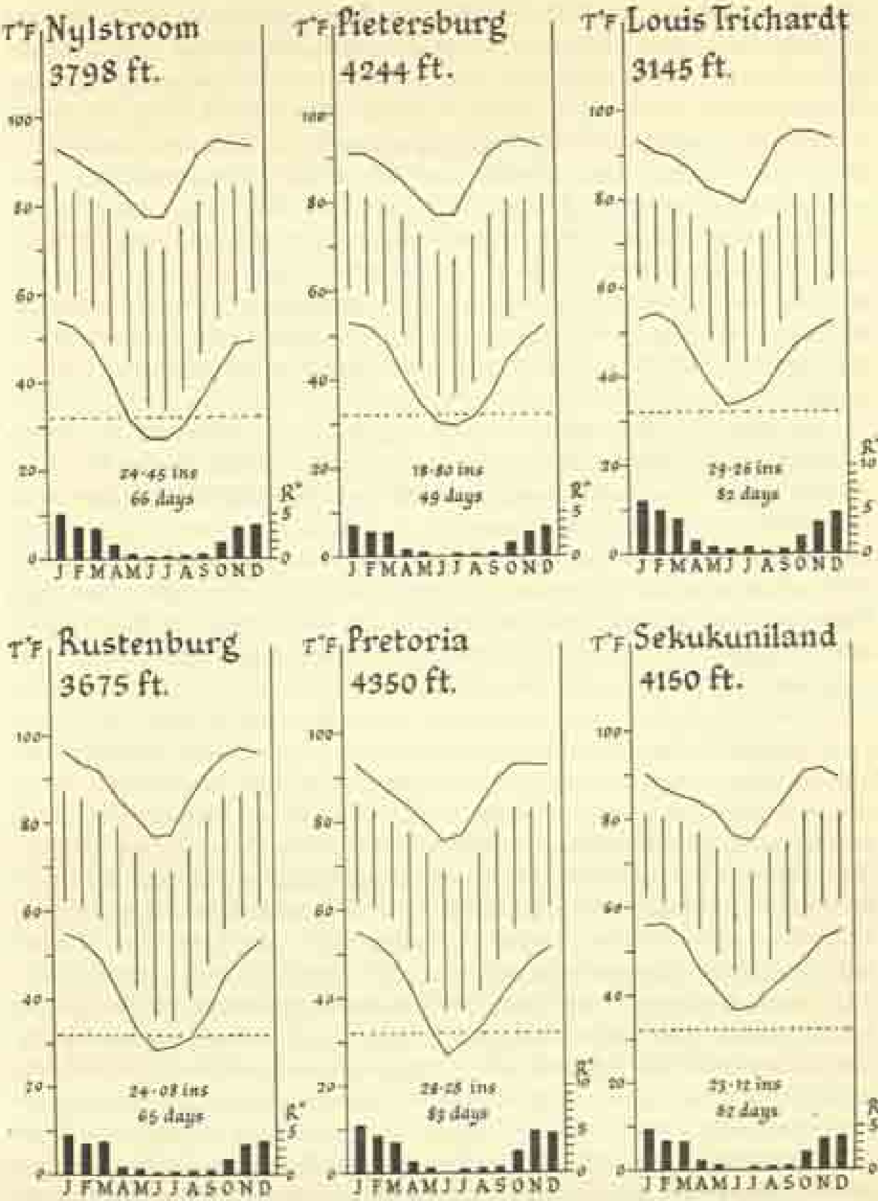


Fig. 227. Cartograms of mean monthly rainfall and temperature at selected stations in the Transvaal Plateau Basin.

Mean daily maximum and minimum temperatures are given by the upper and lower ends respectively of the vertical lines; the continuous lines above and below represent the mean monthly maxima and minima.

The grassveld is dominated by *Themeda triandra* (redgrass) which with the less frequent species of *Digitaria*, *Eragrostis* and *Panicum* affords rich and palatable grazing; scattered through it the shrub *Sesbania mossambicensis* gives excellent forage at the end of winter when the grasses are dry and the grazing scarce. In striking contrast the sandveld is heavily wooded with vaalbos (*Terminalia sericea*) and sering (*Burkea africana*) as the dominant trees; grass is scanty and of poor grazing value. Where the red sandy loam occurs rooibos (*Combretum apiculatum*) prevails; there are some *Acacia* spp. and an undergrowth of shrubs and redgrass; the veld is regarded as sour but it provides fair grazing and is a useful change for stock. Along the margins of the Nyl vlei grassy glades alternate with dense bush; the latter affords warmth and shelter in winter while the glades provide some of the most palatable and best fattening grazing in the country.

Despite the prevalence of tickborne diseases, now controlled by regular dipping, the quality and variety of the grazing, combined with the fact that some natural fodder is available throughout the year, encouraged large-scale cattle farming in the Bushveld basin soon after the Anglo-Boer war. Even today the area remains essentially a pastoral one with the main emphasis on beef production, although dairying to supply fluid milk to the Pretoria market is important along the railway line to Marble Hall. Where the farms have a river frontage the small strips of alluvial soil are used for tobacco and winter wheat, which are irrigated with water pumped from the river (Plate 34).

Extensive arable cultivation, however, is important on the Springbok Flats, while intensive farming concerned mainly with horticultural and speciality crops characterizes the irrigation schemes at the junction with the Bankeveld.

Agriculture began on the Southern Flats in the early years of this century when, under the Milner government, families were allotted land at Settlers. The Northern Flats were not divided into farming settlements until much later. At first cattle and maize were the sole interests. After the first world war peanuts were tried and before long promised to become the leading crop. Their production, however, was hampered by low prices during the 1930's and it was only after 1934, when agreements between the growers and oil expressers led to the fixing before planting time of the basic prices for the following season's crops, that the place of peanuts in the economy of the region became assured. The demand for edible oils during the second world war greatly stimulated production and since then continuing demand and high prices have encouraged a further expansion in the acreage under the crop. Today the Springbok Flats account for 20 per cent of the Union production. Farms average about 1,000 morgen. About 70 per cent of the land is in grazing, while the arable is divided about equally between maize and peanuts; maize, however, tends to be more important in the south, where the rainfall is a little higher and black turf soils prevail; and peanuts in the north, where red, heavy loams and red, sandy soils are common. Although difficult to work and a quagmire after rain, the black turf is very fertile and yields good crops

of maize. It is less suited to peanuts which are difficult to lift from it. On the other hand the red, heavy loams are suited to peanuts, but maize grown on them falls victim to 'rooiblom', a parasitic disease. Hence the distinction between the Northern and Southern Flats.

The areas of intensive farming, being dependent on irrigation, occur near the junction of the Bankeveld and Bushveld where the main rivers leave the gorges in the quartzite ridges to occupy open valleys which, in many cases, are paralleled by alluvial terraces. In the north-east the extensive citrus groves of Zebediela Estates (Plate 46) have been laid out on deep basaltic loams immediately south of the Strydpoort range. The irrigation water comes from three small dams constructed across the poorts which the Gompies and Zebediela rivers have cut in the Chunies mountains. These streams, however, rising on the Pietersburg plateau where only moderate summer rains are received and having relatively small catchment areas carry neither large nor reliable volumes of water. Consequently the supplies have proved inadequate for the half-million trees already planted and large crop losses have been experienced in drought years. Underground sources of water have recently been tapped and it is hoped to make up the deficiency from this source. It is doubtful, however, whether sufficient water will be found for irrigating the further extensive areas along the northern margin of the Flats which are climatically and edaphically suited to citrus trees. Zebediela Estates thus seem likely to remain an isolated self-contained community in which Natives provide the labour in the groves and Europeans supervise the cultural operations and do all the work in the packsheds.

Intensive farming is important also on the various irrigation schemes along the upper valleys of the Groot Marico, Crocodile, and Olifants rivers (see ch. 7, pp. 137–8). Here citrus fruit production is again important west of Hartebeestpoort where the Magaliesberg effectively excludes cold southerly air-streams in winter. Most of the groves are near the foot of the Magaliesberg (Plate 48) where they occupy the light loamy soils derived from an admixture of quartzite and norite parent material. Tobacco and winter wheat are grown on the black turf soils of the norite and are particularly important on the Hartebeestpoort and Loskop irrigation schemes. Potatoes are grown on the lighter sandy soils. Vegetables and flowers are produced on those schemes situated within easy reach of the Pretoria market and dairying based on lucerne has become important on the Hartebeestpoort settlement. Grapes for the early season market are grown on the Loskop scheme.

Native reserves occupy a large area but are found mainly on the poor sandy granitic areas and in the waterless tracts of the norite (Plates 135 and 136). Their agriculture is backward and poor. Cattle rearing is the main concern but overgrazing has, in many cases, left the bare ground at the mercy of torrential summer downpours and gullies have been torn into the surface, particularly in the norite zone of Sekukuniland (Plate 138). Some maize is grown but kaffir corn (Plate 137), which withstands better the hot arid conditions, is more important. In the

waterless norite zone of Sekukuniland the people live in agglomerated settlements of mud and thatch huts, surrounded by high sisal 'hedges'. The sites of these settlements are sometimes determined by a perennial stream, as at Schoonoord below Thama Koosh, but more often by an uncertain water-hole or intermittent stream as at Magnet Heights. Numerous reliable springs give a better supply of water on the granite, where the kraals are more scattered, but here the soils are poor and grazing inferior.

The Bushveld basin is renowned for its mineral wealth, platinum and chromite occurring in the norite, tin in the Rooiberg series, corundum in the red granite, limestone and marble in the Dolomite, and soda in the Pretoria caldera. The working of these minerals has led to the growth of a number of small mining settlements (see Fig. 226) and occasioned the extension of railway lines to Marble Hall and the Steelpoort Valley, but otherwise has exerted little influence on the economy of the area.

The whole area is essentially one of dispersed settlement. Apart from Rustenburg the only towns occur along the main railway line from Pretoria to Beit Bridge and are essentially small collecting and supply centres of 2,000 to 4,000 people serving the surrounding agricultural areas. All have trebled their population since 1921, a reflection of the increasing importance of crop production and the trend towards closer settlement.

Rustenburg, today the largest town in the Bushveld Basin, has experienced a rapid growth during the past fifteen years. In 1936 it had little more than 6,000 people. By 1946 its population exceeded 11,500 and by 1951 more than 14,000. Situated near the contact of Bushveld Basin and Bankeveld it is an important market centre for both regions. It has benefited from the prosperity enjoyed by the citrus and tobacco farmers following the building of irrigation schemes; it serves as a supply centre for the nearby platinum and chrome mines and now has a platinum refinery. In addition it has a small tourist industry, people coming from Johannesburg and Pretoria to enjoy the scenery and the climbing in the Magaliesberg. Potgietersrust, much smaller, has a similar situation at the northern limit of the Basin commanding the route northwards while Warmbaths, numbering only 4,000 people, enjoys a central position within the basin on the same route. Both serve as collection and supply centres for the surrounding farms and nearby mines while in addition Warmbaths attracts tourists to its warm springs.

The Northern Plateaux

By contrast these are poor areas lying at more than 4,000 feet above sea-level and experiencing relatively cool summers and distinctly severe winters. The soils are generally infertile, being thin, sandy, and deficient in plant nutrients. Much of the area is in Native occupation and except in a few favoured localities where dams for irrigation purposes have been built in recent years, cattle rearing and the raising of the odd patch of maize are the only activities.

The Palala or Waterberg plateau constitutes a level plateau surface declining gradually north-westwards in conformity with the dip of the underlying sandstone, and overlooking both the Bushveld Basin on the south and the Limpopo valley on the north by steep scarps. Standing at an average altitude of 4,000 feet, the surface is characterized by rocky outcrops and thin sandy soils. It carries a vegetative cover of grasses or low bushes which yield only poor and generally sour grazing. There is some cultivation in the valleys, groundnuts being the main crop.

More interesting are the Pietersburg plateau and the Soutpansberg. The former, also with an average elevation of 4,000 feet, comprises an extensive level surface from which rise numerous low inselberge (Plate 142). It is entirely developed on the Old Granite. It is drained mainly to the north by the Sand river but short streams are eating into it from the Strydpoort range in the south and the Great Escarpment in the east. It has been suggested that this area was a source region for the material deposited in the Bushveld basin and the depression north of the Soutpansberg in Karoo times and that extensive stripping went on for a very long period, eventually exposing the Old Granite.[4] The process, however, was not completed before uplift along the Soutpansberg axis and sagging in the Bushveld basin initiated a new cycle of erosion so that unconsumed portions remain as inselberge. This plateau carries only a poor grass cover used for grazing Native cattle. The greater part of the area is a Native reserve and clusters of mud and thatch huts, nestling at the foot of the inselberge, perhaps for shelter from the bleak winds of winter, are a feature of the landscape (Plate 142).

The Soutpansberg presents two striking features. The first is the succession of west–east trending ridges of which it is composed. The whole is built up of shales and quartzites of the Waterberg system overlying volcanic rocks of Dominion Reef age and dipping gently towards the north. The rocks have been disturbed by faulting parallel to the strike. Weathering along these lines of weakness has etched out vales in which the ancient lava is exposed; while above, the resistant quartzite produces ridges with steep south-facing escarpments and gentle slopes northwards. Four such ridges stand out and are known as Hangklip, Wyllies Poort, Masekwas Poort, and Dongwe ridges. To the north patches of Karoo beds have been preserved. These provide the clue to the origin of the second outstanding feature, namely the very deep narrow poorts by which the rivers cross the ridges on their way to the Limpopo. The most impressive are Waterpoort and Wyllies Poort. The former, more than 1,500 feet deep, carries the Sand river and is followed by the railway. The latter, nearly 1,500 feet deep, is so narrow that it barely gives sufficient room for two-way traffic on the main road to Beit Bridge and Rhodesia, which utilizes it. This poort is occupied by the Marandanyombe river which normally carries only a moderate amount of water. In this and other poorts the rivers have taken advantage of joint planes but the main reason for their existence lies in the development of the initial drainage on a Karoo cover and its superimposition on to an ancient surface.

Their great depth results from active downcutting against the uplift of the Soutpansberg in Tertiary times. During these processes there has been some adjustment to structure and subsequent streams have developed in the intervening vales. Here the only intensive agriculture is found, specializing, with the aid of irrigation, in the production of out-of-season vegetables and tropical fruits for the town markets. The southern slopes of the ridges are clothed in plantations of pine and eucalyptus trees which flourish in the cool misty conditions. In the drier areas cattle rearing is the sole activity. However, the beautiful scenery, the cool summers and mild winters have encouraged beginnings in the development of a tourist industry.

Louis Trichardt is the only town of note. It stands on a ledge of lava at the foot of the southern ridge and derives its importance today from its command of the route through Wyllies Poort to Rhodesia, and its junction position between Bushveld and Lowveld.

Beyond Wyllies Poort the lowland of the Limpopo–Sabi depression is reached and vegetation changes reflect the lower rainfall in the lee of the mountains.

BIBLIOGRAPHY

1. J. H. WELLINGTON. 'Stages in the process of river superimposition in the southern Transvaal'. *S.A. J. Sc.*, Vol. XXXVII, 1940.
2. J. H. WELLINGTON. 'The Vaal–Limpopo watershed'. *S.A.G.J.*, Vol. XII, 1929.
3. A. L. HALL. *The Geology of Sekukuniland.* Geol. Surv. of S.A. Pretoria. 1911.
4. See M. S. TALJAARD. *A Glimpse of South Africa.* University Publishers, Stellenbosch, 1949, pp. 167–213.

The Population and the Future

43

Population

Introduction

In 1957 the population of the Union of South Africa numbered 12,646,375 people distributed over 472,733 square miles, giving an overall density of 27 persons per square mile. More than 5 million – about 42 per cent – of the people, however, were urban residents and the rural density was only 15 persons per square mile. In Bechuanaland (area 275,000 square miles, population, in 1946, 296,310 persons) and South West Africa (area 317,725 square miles, population 414,610 persons), the density at 1·08 and 1·3 persons per square mile respectively was much lower. Overall Southern Africa is indeed a sparsely peopled area.

What Southern Africa lacks in numbers of people she makes up in the complexity of her population problems. The population is made up of four distinct racial groups – European, Bantu, Asiatic, and 'Coloured'. Out of a total population of 14 million the Bantu number nearly 10 million, the Europeans about 2½ million and Asiatic and Coloured people less than 1½ million. Most of the European, Asiatic and Coloured people live in the Union of South Africa where the population problems are most complex.

Table 31. The Population of Southern Africa by Territory

	Europeans	*Asiatic and Coloured*	*Bantu*	*Total*
Union of South Africa 1951 census	2,643,187	1,467,847	8,535,341	12,646,375
South West Africa 1951 census	48,588	16,903	349,110	414,601
Basutoland 1946 census	1,689	876	561,289	563,854
Swaziland 1946 census	3,201	745	181,269	185,215
Bechuanaland 1946 census	2,379	1,176	292,755	296,310
Total	2,699,044	1,487,547	9,919,764	14,106,355

The Distribution of Population

In most countries the distribution of population very largely coincides with the distribution of economic resources and of human activities. In other words it depends on the capacity of the land to support people in agriculture, mining, industry, or commerce. In South Africa, however, this 'economic' distribution is modified by the superimposition of a racial distribution having its origin in the pattern of occupation of the country by different racial groups (see chs. 5 and 6) and perpetuated in the allocation of land between them and in the laws controlling the movement and employment of those of Non-European descent.

Three features of the population distribution are outstanding – the density of population in the eastern part of Southern Africa as compared with its sparseness in the west, the marked concentration in a number of urban areas, and the regional concentrations of certain racial groups.

The Contrast between East and West

The overall distribution of population indicates a decreasing density with a diminution in the total annual rainfall, and the country west of the 20-inch summer rainfall isohyet and north of the 10-inch winter rainfall isohyet is very sparsely settled except for limited areas along rivers where irrigation is possible. This decreasing density more or less coincides with the change from the diversified farming country of the east and south-west to the purely pastoral areas of the central and northern Cape, Bechuanaland, and South West Africa.

Within the more densely peopled area variations of relief and rainfall, the occurrence of mineral wealth, and a complex of geographical factors promoting manufacturing industry, commerce, and trade are, however, responsible for differences of density within short distances. The most striking contrasts of density occur in the Cape Folded Belt where the high rugged mountains are virtually uninhabited and the population is concentrated in the valleys – the Tulbagh, Ceres, and Elgin basins, the Hex and Breede river valleys and around Paarl, Wellington, Somerset West, and Stellenbosch where intensive farming based on fruit production is responsible for relatively high rural densities (Figs. 228 and 231). In the eastern part of the country the high Drakensberg of Natal and Basutoland, inaccessible and inhospitable, is also uninhabited whereas the neighbouring valleys and the adjacent Highveld of the Orange Free State and Middleberg plateau of Natal are well peopled. In the northern Transvaal striking contrasts of population density related to differences in the annual rainfall distinguish the relatively closely settled Transvaal Plateau Basin from the little inhabited Limpopo trough and the eastern Lowveld (Figs. 228 and 229). Particularly marked is the contrast between the densely settled wet southern slopes of the Soutpansberg and the arid thinly populated northern parts of this mountainous area. In the eastern Transvaal the sharp transition from the well-watered, well-populated Highveld to the sparsely settled drier Lowveld culminates in the uninhabited belt of the Kruger National Park wild game sanctuary.

In several parts of the country the general population distribution is modified by pockets of dense rural settlement along the major river valleys where irrigation permits intensive farming. Outstanding are the Vaal–Hartz valleys in the northern Cape, the Great Fish and Sundays river valleys in the south-eastern Cape, the Olifants river valley in the south-western Cape, and the valleys of the headstreams of the Limpopo and Olifants rivers in the Transvaal Bushveld. Additional pockets of dense population occur around mining centres, e.g. around the iron ore mines of Thabazimbi, the manganese mines of Postmasburg, the coalmines of Natal and the eastern Transvaal – and in communications and supply centres.

All these concentrations, however, are insignificant compared with those of the big urban centres.

The Concentration of the Urban Population

The most striking concentrations of people occur in the Pretoria–Witwatersrand–Vereeniging area of the southern Transvaal and around the ports of Cape Town and Durban, smaller ones centre on the cultural and administrative centres of Bloemfontein and Pietermaritzburg, the port of East London, and the mining town of Kimberley while a new one is arising in the Odendaalsrus goldfield of the Orange Free State.

By far the most important and most rapidly growing of the urban concentrations is that of the Pretoria–Witwatersrand–Vereeniging area which constitutes the one real conurbation on the African continent. Covering less than 5,000 square miles it contains more than 2 million people. Indeed about 17 per cent of the total population of the Union of South Africa live here on 1 per cent of its area. The conurbation has arisen from the growth and coalescence of a number of nuclei, each of which originated with a specific function – the towns of the Witwatersrand as gold mining centres, Pretoria as the administrative capital, first of the Transvaal republic and later of the Union, and Vereeniging-Vanderbijl Park as the great iron and steel centre of the country. Long continued gold mining and the subsequent concentration of industry have made the southern Transvaal the economic centre of the Union, and Johannesburg its commercial and financial capital. With the momentum of its varied functions the conurbation is expanding rapidly. Its population doubled between 1936 and 1957 and today with the development of the Free State and Klerksdorp goldfields and the exploration of the eastern Transvaal field its sphere of influence is widening and its tentacles spreading outwards (Figs. 228 and 229).

Originally people gathered around the ports to carry on trade with overseas countries. A variety of ancillary activities attracted others and later the growth of industries brought about marked concentrations of people. Today these are as much the product of industry as they are of trade although with the exception of Cape Town the size of the population is in direct proportion to the volume of trade handled. Cape Town, however, with a smaller tonnage of traffic than Durban houses more people. This is due in part to the more valuable and more varied

nature of her trade and to her role as premier passenger port. Mainly, however, it is due to her function as seat of Parliament, commercial and cultural centre of the Union and regional capital of the Cape, with its prosperous farming areas of the south-western corner. In Natal, Pietermaritzburg is the administrative and cultural centre, leaving Durban to function primarily as port and industrial city. The population concentration of Port Elizabeth is centred mainly on the port but Uitenhage is an industrial satellite some ten miles inland.

Of the smaller urban concentrations of people Kimberley might have been expected to decline with the relative decrease in importance of its diamond mines. That it has not done so but instead has continued to attract people is due to its function as a railway centre and its growth as an industrial town. By contrast although consumer industries have grown up in Bloemfontein, the concentration of people there is due largely to its function as administrative and cultural centre of the Orange Free State and seat of the Judiciary of the Union.

The Distribution of Racial Groups

Apart from the concentrations of people in the major urban areas which are clearly the result of economic activities and are based on natural resources, the variations in the population density which can be attributed to physio-economic causes pale before the variations which are connected with the distribution of the racial groups and which are imposed by the division of land and rooted in the history and politics of the country.

At the time of Union in 1910 the major racial population pattern had been set. Broadly speaking, by virtue of the course of settlement (ch. 6) the Europeans occupied the Cape west of the Great Fish river and the greater part of the plateau. The Bantu held most of the land in the Transkei and Ciskei and in the Protectorates. Natal and Zululand were divided between European and Bantu. Indians had been introduced into Natal, Coloured people had emerged in the Cape.

After Union the distribution of land occupance as between European and Bantu was virtually confirmed by the Native Lands Act of 1913. Provision was subsequently made, however, in terms of the 1936 Native Trust and Land Act, for the release of certain areas from the terms of the 1913 Act, these areas to be available for purchase either by individual Natives or by the South African Native Trust for Native occupance. Up to the end of 1952 nearly 4½ million morgen (about 29,000 square miles) had been purchased and the area of Native owned territory increased by 64 per cent since 1913. Most of the land purchased is in a belt of country stretching across the Bushveld of the Transvaal.

Today the distribution of the European and Bantu population faithfully reproduces the division of land between them, with the important corollaries, however, that Bantu townships form important appendages to the major European towns while large numbers of Natives live and work on European farms. Very few Europeans are to be found in the Bantu areas. The Indians live mainly

118. The Transvaal Highveld near Greylingstad. The level plateau surface is underlain by Karoo rocks. The hills in the background are formed of Ventersdorp rocks which protrude through the Karoo cover. The flowers in the foreground are wild cosmos.

119. Typical Karoo landscape north of Nelspoort. The kopjes rising from the level plateau surface are known as the Three Sisters. They are formed of Beaufort sandstone capped by highly resistant dolerite. More extensive remains of the dolerite sill may be seen on the right and also behind the kopjes.

120. The Upper Karoo between Three Sisters and De Aar, showing in the foreground the effects of sheet erosion. The kopjes are capped with Beaufort sandstone.

121. View westwards over Johannesburg and the 'Reef'. In the background the Witpoortje 'break' revealed by the absence of mine dumps.

122. The heart of Johannesburg, showing the commercial hub (top right) and central residential area where tall office blocks and luxury flats are replacing the old single-storey houses. In front the new bridges spanning the railway can be seen. The natural routeways are E.–W. People move from the north and south to work in the city centre. The rectangular lay-out of the central Johannesburg is clearly seen.

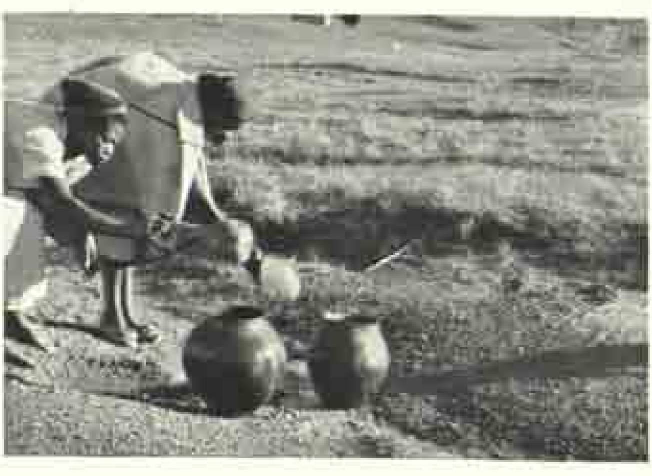
123. The Enstra pulp and paper mill at Springs. Spacious sites on level terrain, good rail communications and available power and water supplies have attracted industry to the East Rand. The railway is the main Johannesburg–Witbank line. The dam (top right) has been constructed across the Blesbokspruit, tributary to the Vaal river.

124. A Bantu home in a squatters camp. Such camps grew up on the outskirts of European towns and adjoining existing Native locations during the period of rapid industrial growth during and following the Second World War. They are now being cleared as new housing in new Native Townships is provided by Government and Municipal authorities.

125. New Houses for Bantu occupants typical of that provided by Government and Municipal authorities in new Native Townships.

126. Typical Basuto home in 'Lowland' Basutoland. From right to left are the living hut, sleeping hut and store hut. The woman is a Matabele married to a Basuto. Both are wearing the traditional blankets.

127. Stacking 'lisu' (dried dung) which is used for fuel in Basutoland.



128. Women collecting water from a local spring in Basutoland.

129. The Basutoland plateau near Lehaha la Sekonyani (9,000 feet), showing in the foreground the alpine veld and a cattle post.

130. A Basuto cattle post which is developing into a permanent upland settlement. The light patches on the mountain slopes in the background are wheat fields. The stooks are of wheat.

131. Contour cropping in an attempt to combat erosion in the mountains of Basutoland where the population pressure on the land has led to the use of steep slopes for crop production and to some of the worst erosion anywhere in the world.

132. The Western Bankeveld showing the Daspoort range in the foreground and the Magaliesberg in the background. The poort is that cut by the Crocodile river which is dammed at Hartebeestpoort.

133. View westwards across the Eastern Bankeveld to the Lulu mountains.

134. European-owned lands used for wheat cultivation in the Steelpoort valley. All the fertile and irrigable valleys in the Eastern Bankeveld are owned by Europeans who grow wheat and tobacco. The poorer lands belong to the Bapedi. Compare this photograph with Plates 135–8.

135. Typical thorn country of Sekukuniland. The Pedi women do all the cultivation, the collecting and carrying of water, fuel and provisions. Their dress – heavily embroidered smocks worn over leather 'aprons' – hair style and innumerable bangles denote their married status. The smocks were first introduced in relief clothing sent by Queen Victoria after the Bapedi wars.

136. A typical Pedi hut in the semi-arid country of Sekukuniland, home of the Bapedi. Note the bare rocky ground practically devoid of soil and the scanty vegetation cover with thorn trees and succulent euphorbias as the characteristic plants.

137. Ripening mabela grown by the Bapedi in Sekukuniland.

138. Severely eroded land in Pedi occupance near Jane Furze Hospital in Sekukuniland. The scale of the dongas may be gauged from the figures of the two women in the middle distance.

139. The level bush-covered floor of the Transvaal Bushveld Basin. The ranges in the background are built of Transvaal rocks rifted up during the igneous intrusion. The light patches are irrigable lands used for tobacco and wheat cultivation along the Pienaars river.

140. The soda caldera north-west of Pretoria. With a diameter of two-thirds of a mile its floor lies some 200 feet below the level of the surrounding country. Its rim rises 400 feet above its floor. It is worked for both salt and carbonate of soda, the pipes and pumping plant connected with the boreholes being visible in the centre right.

141. A typical Bushveld scene, showing the characteristic vegetation of tall grasses and thorny acacias with in the background the barns in which the tobacco is air-dried.

142. The Pietersburg Plateau showing the level peneplaned or pediplaned surface studded with inselberge developed over the Old Granite.

in Natal, their place of introduction, their concentration being in part due to legislation preventing or restricting their entry into other provinces. The Coloured people remain very largely in the Cape where they enjoy more privileges than elsewhere.

The concentration of Indians in the coastal belt of Natal in part helps to explain the high population density there. The greatest contrasts of population density, however, occur between the European and Bantu owned areas. The average population density in the Native reserves is about 60 persons per square mile, compared with 4 Europeans and 35 Natives per square mile on the European owned lands in the better watered parts of the Transvaal Highveld, in Natal and the south-eastern Cape. In places in the Transkei the density in the Bantu areas rises to 90 persons per square mile while adjacent European lands carry only 40 per square mile, mainly Natives. The dense population of the eastern Cape and also of Basutoland is in fact due more to Bantu ownership than to the productive capacity of the land. On the contrary much of the land is overpopulated (see chs. 34 and 41). Similarly the high densities in parts of the Transvaal Bushveld coincide with Bantu owned territory. In the northern Cape the Bantu reserves carry more people than the adjacent European owned land but owing to the lack of rainfall and very limited opportunities for any form of agriculture the population is very sparse.

The Distribution of the European Population

Most of the Europeans live on the Highveld plateau and along the eastern and southern coastal belt. There are few Europeans in the Bantu territories and the western Karoo and the Kalahari are very sparsely settled.

The most striking distributional feature of the European population is its concentration in urban areas (Fig. 228). Of the total of 2·6 million persons, 2 million or 77 per cent live in towns. The second outstanding feature is that 1·2 million people or 46 per cent live in the Transvaal and of these two-thirds are concentrated in the Pretoria–Witwatersrand–Vereeniging conurbation. Thirdly the rural population of the Cape province is actually greater than that of the Transvaal mainly as a result of the intensive farming and small farms in the south-western and south-eastern corners of the country.

Table 32. The Distribution of the European Population of the Union of South Africa 1951

	Total	*Urban*	*Rural*
Union	2,642,713	2,071,683	571,030
Cape	936,109	706,024	230,085
Natal	274,240	235,340	38,900
Transvaal	1,204,712	982,248	222,464
O.F.S.	227,652	148,071	79,581

Throughout their history European people have been accustomed to the distinction between town and country, but their very high degree of urbanization in South Africa is due mainly to the fact that they are the initiators and leaders in all economic activities, the directors and overseers. Non-Europeans have traditionally provided the unskilled labour on farm and mine and in factory. The first

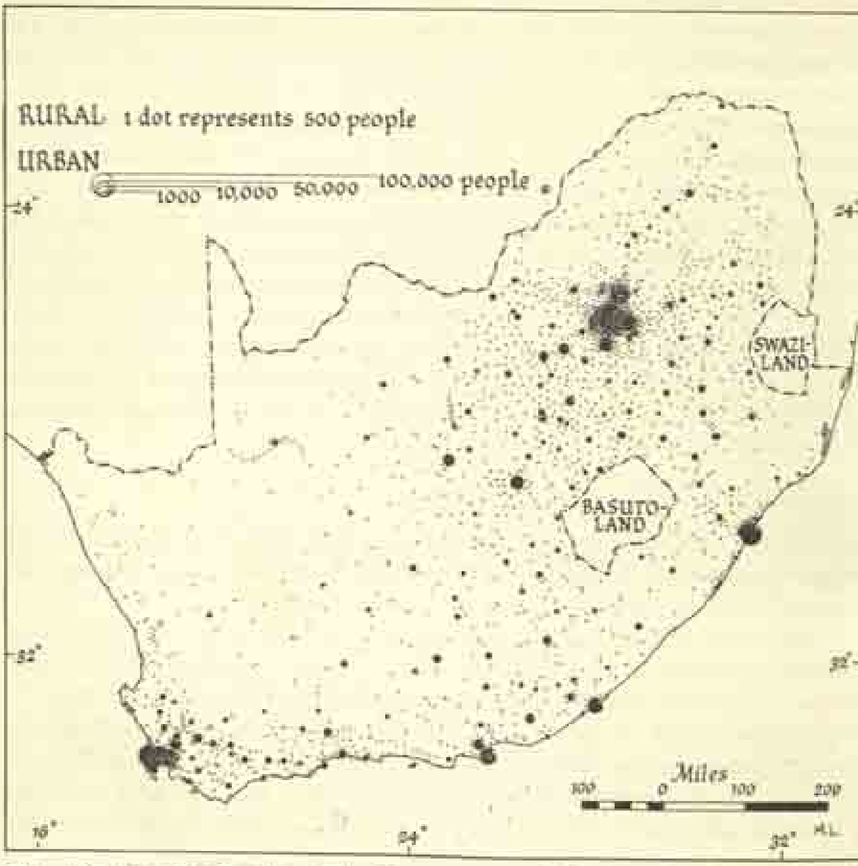


Fig. 228. The distribution of the European population in the Union of South Africa.

(1951 census.)

European settlement, i.e. at the Cape, was urban. Two centuries later gold-mining gave birth to new towns and led to the growth of commerce and industry. Thus when the land could no longer provide farms for all its European sons and daughters it was natural that they should move to the towns to work. The urbanization of the Europeans is in fact very largely a measure of their progress and their ascendancy as directors of the economic activities of the country.

Apart from the concentration of people in the Pretoria–Witwatersrand–

Vereeniging conurbation, on the Highveld the Europeans are fairly uniformly spread on farms and in the evenly distributed towns and villages. The density naturally tends to be higher in the better watered eastern districts. In the Bushveld the distribution is less even with a denser spread in the more favourable arable areas, e.g. the Springbok Flats, and concentrations along the valleys where irrigation is important. By contrast the low country near the Limpopo river is sparsely peopled on account of its low rainfall, the severe incidence of malaria in the past and the presence of the Kruger National Park.

Of the 936,000 Europeans in the Cape Province nearly two-thirds live in a comparatively small area south of the Great Escarpment where they are distributed mainly in coastal towns and along intermontane valleys. In Natal 67 per cent of the Europeans live in Durban and Pietermaritzburg and the remainder either along the coast where there are numerous resorts or in a belt on either side of the railway line to the Transvaal and Orange Free State.

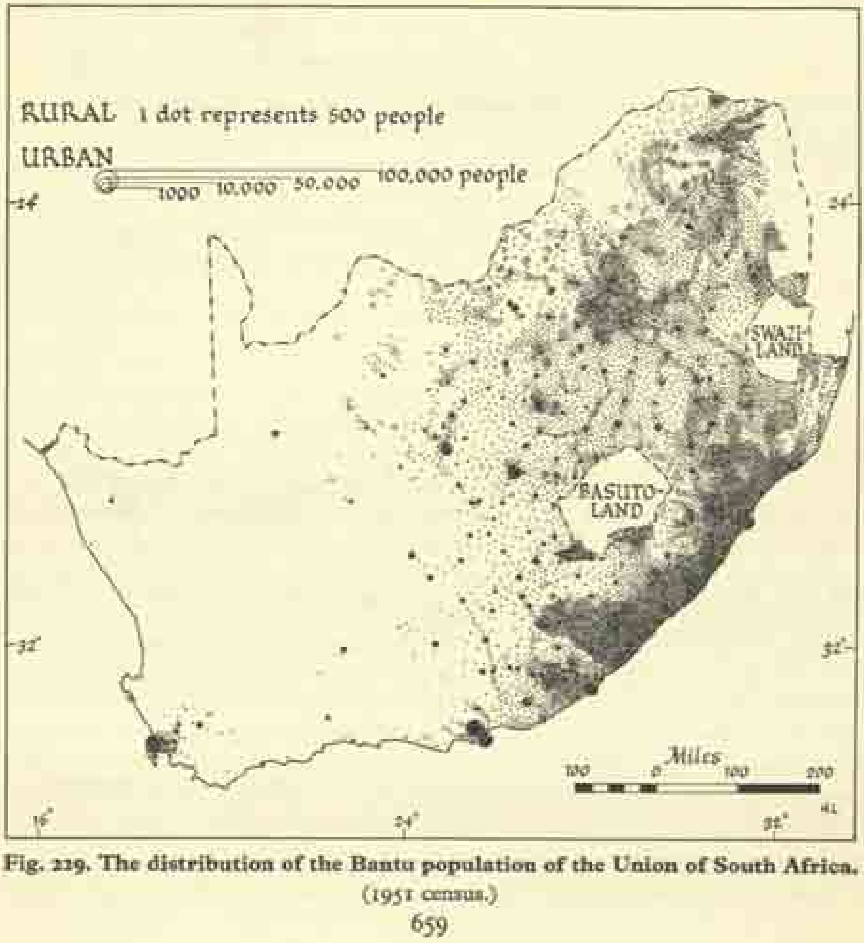


Fig. 229. The distribution of the Bantu population of the Union of South Africa. (1951 census.)

The Distribution of the Bantu Population

The Bantu population is concentrated in the eastern half of Southern Africa, particularly in the Protectorates and in the Union Reserves (Fig. 229). In the latter 3·6 million people representing 43 per cent of the total live on 13 per cent of the total surface area of the Union. A further 2·6 million or 30 per cent live on European farms, where their distribution follows that of the Europeans and the rainfall, the density decreasing westwards. The remaining 2·3 million Union Bantu live in the European urban areas and particularly in the southern Transvaal.

The Bantu population is pre-eminently rural, 73 per cent of the people living on farms. In the Native territories there are virtually no Native cities or towns, those which do occur, e.g. Umtata in the Transkei, Maseru in Basutoland, Mbabane and Bremersdorp in Swaziland, being European creations. Within the

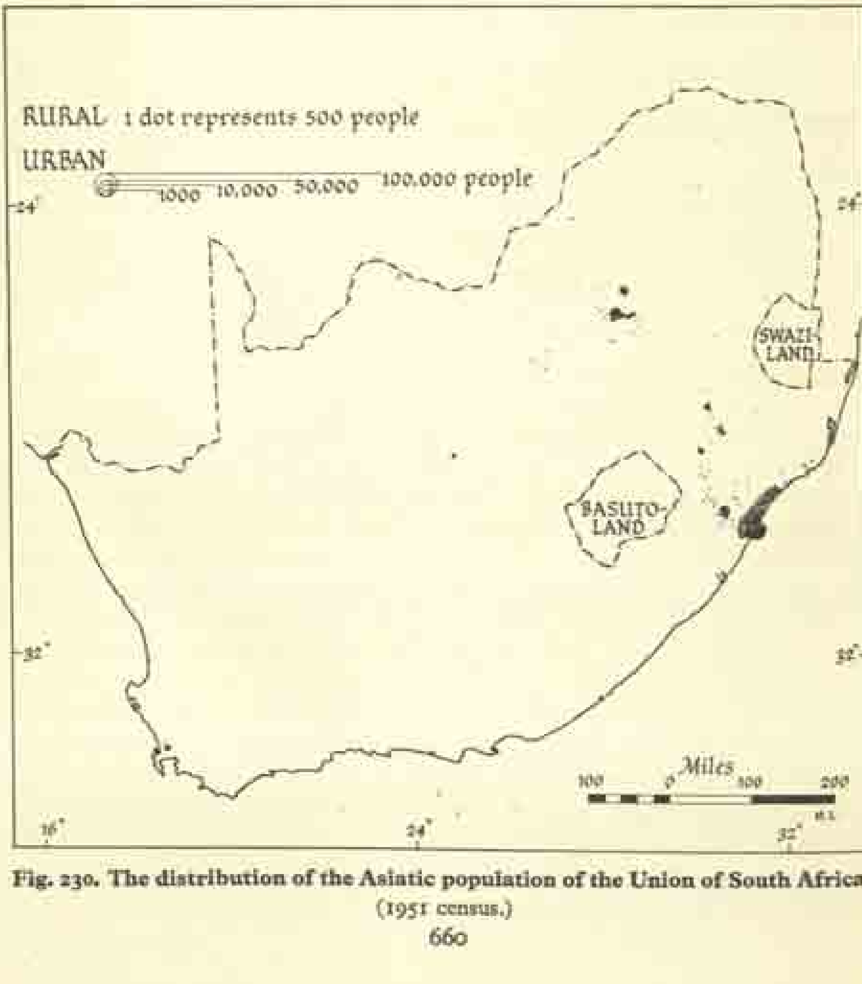


Fig. 230. The distribution of the Asiatic population of the Union of South Africa. (1951 census.)

Bantu territories the population is remarkably evenly distributed, this feature being particularly obvious in the Transkei where their huts are scattered throughout the area.

The Distribution of the Asiatic Population

The Asiatic population, mainly Indian, is strongly concentrated in Durban and in the coastal strip of Natal. Indeed 300,000 of the 366,000 Asiatics in the Union live in Natal and 151,000 of them in Durban (Fig. 230).

Although the Indians were originally brought in to work in the sugar cane plantations today 78 per cent of them live in cities and towns, particularly in the Natal coastal belt. They have, however, spread inland to the towns along the railway line to the Transvaal – to Pietermaritzburg, Ladysmith, Dundee, Glencoe, and Newcastle, while some have settled in the big cities of the Transvaal and the Cape where they operate as traders. They are excluded from the Orange Free State by legislation.

The Distribution of the Coloured Population

Nearly all the Coloured people live in the Cape Province where their distribution follows very closely that of the Europeans (Fig. 231). While they provide all the labour on most Cape farms nevertheless 65 per cent of them live in towns, particularly Cape Town and Port Elizabeth. Smaller numbers live on the Witwatersrand and in the other big towns whither they may have migrated or more probably originated through miscegenation.

Population Trends and Movements in the Union of South Africa

While any analysis of the growth of population and changes in its distribution and density are hampered by the inadequacies of the census returns, particularly in respect of the Bantu, nevertheless certain important trends may be discerned (Table 33).

The increase in all racial groups since 1904 is high. In the case of the Non-Europeans and particularly the Bantu part of the increase is attributable to their more complete enumeration with each successive census. In all groups immigration has been of minor significance. The limited amount of European immigration has been more than counterbalanced by emigration. While many Bantu enter the Union to work on the mines the number of permanent immigrants is confined to those crossing the border illegally and the numbers, although probably considerable, are unknown. The number of Coloured people is no doubt continually augmented by the offspring of intercourse between peoples of different races, particularly mixed marriages between Bantu and Coloured, but at the same time there is a loss of people 'trying for white' and 'passing over the line' into the European group. The immigration of Asiatics is controlled and between 1911 and 1921 about 29,000 Indians returned to India under a repatriation scheme. In all groups the growth of population is thus due to natural increase, i.e. excess of

Table 33. Increase in the Population of the Union of South Africa according to Race 1904–51

	1904	1911		1921		1936		1951	
		1	2	1	2	1	2	1	2
European	1,117,234	1,276,319	1·93	1,521,343	1·76	2,003,334	1·86	2,641,689	2·12
African	3,490,291	4,018,878	2·03	4,697,285	1·57	6,596,597	2·29	8,556,390	1·98
Asiatic	122,311	152,094	3·12	163,594	0·86	219,691	1·90	366,664	4·46
Coloured	444,991	525,466	2·41	545,181	0·37	769,142	2·32	1,103,016	2·89

1. Numbers. 2. Average annual rate of increase during intercensal periods.

births over deaths. The European birthrate was 32·8 per 1,000 in 1904 and although it subsequently fell reaching its lowest level in 1936 it has since risen and in 1954 at 25·5 per 1,000 was high by European standards. The decrease in the European birthrate has to some extent been counterbalanced by a reduction in the death rate from 10·43 per 1,000 in 1904 to the remarkably low figure of

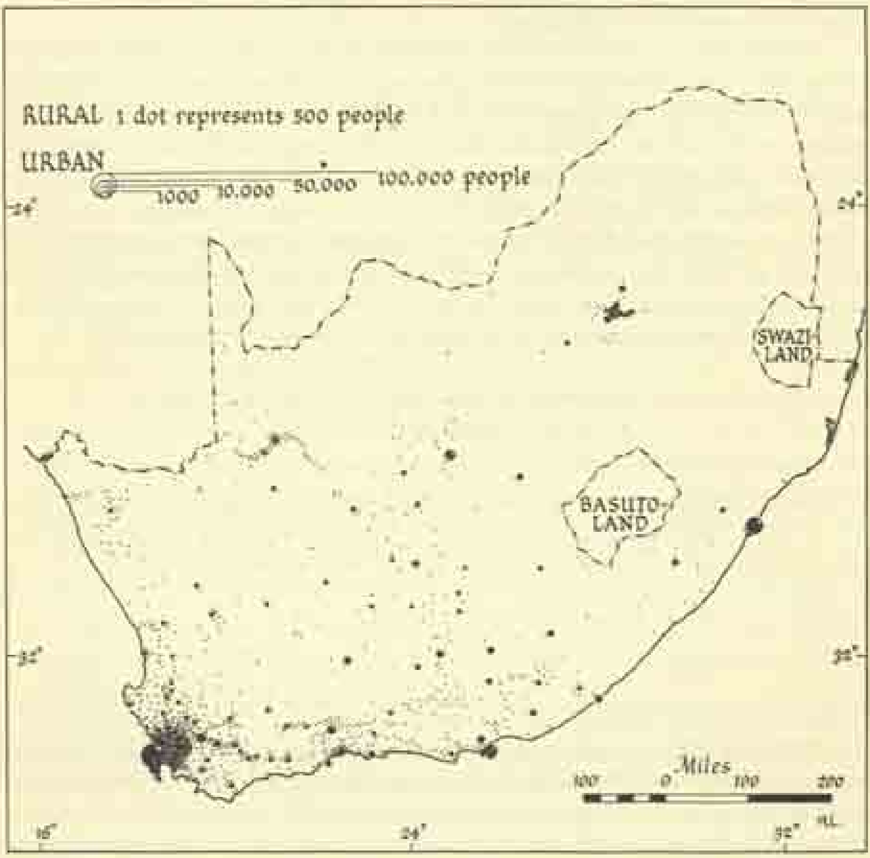


Fig. 231. The distribution of the Coloured population of the Union of South Africa.
(1951 census.)

8·7 in 1954. The net reproduction rate calculated at 1·308 per 1,000 in 1940 is higher than in most other countries with a European population. Reliable data concerning the birthrate and deathrate among the Bantu are lacking but there is little doubt that hitherto their society, in which material progress and an easy life have depended largely on the possession of a large family, has ensured a high birthrate. This, however, has been counteracted by considerable infant mortality

and a high overall deathrate, consequent on ignorance and poverty. Among the Coloured people the birthrate in 1954 at 48·4 was one of the highest in the world exceeding even that of Egypt, but many babies died in infancy and the overall deathrate at 18·4 per 1,000, although lower than in 1939 when it was 23·1 per 1,000, was still extremely high. The Indian section of the population with birth and death rates respectively of 35·7 and 9·1 per 1,000 in 1954 is increasing more rapidly than any other racial group.

Largely because high deathrates have counterbalanced the higher birthrates among the Non-Europeans the racial composition of the population has remained remarkably stable. The proportion of Europeans has fallen only very slightly relative to that of the Non-Europeans but the numerical increases among the latter and particularly the Bantu have of course been very much greater. The urbanization of the Bantu and with it the value attached to money, a house, a bicycle, education and cheap luxuries, etc., instead of cattle, wives, and children, may lead to some decrease in the birthrate but this will probably be offset by a decline in the deathrate. In regard to the Coloured and Asiatic people urbanization has not been accompanied by a reduction in the rate of increase.

Table 34. Proportion of Each Race to Total Population of Union of South Africa 1904–51

Year	*European* (%)	*Native* (%)	*Coloured* (%)	*Asiatic* (%)	*Total Non-European* (%)
1904	21·6	67·4	8·6	2·4	78·4
1911	21·4	67·3	8·8	2·5	78·6
1921	21·9	67·8	7·9	2·4	78·1
1936	20·9	68·8	8·0	2·3	79·1
1951	20·9	67·5	8·7	2·9	79·1

With a steadily increasing population some change in the overall distribution has naturally occurred. In the first place there has been a general sustained movement of Europeans to the towns. In some areas, notably the Karoo, the European farm population has actually decreased while even in the better agricultural areas, notably in the valleys of the south-western Cape and on the Transvaal Highveld, the increase has been small. Only in new areas opened for occupation by virtue of malarial control, e.g. the Lowveld and where irrigation schemes have made possible intensive crop production in hitherto pastoral areas, has there been any significant increase. That the European rural population has remained static despite a more intensive use of the land and a more diversified economy is explained very largely by dependence on Native labour on the farms and also more recently by increasing mechanization. The trends indicate, however, that according to the present standards and agricultural economies the European farming areas are fully occupied.

Table 35. The Rural/Urban Distribution of the Racial Groups in the Union of South Africa 1921–51

	1921		*1936*		*1951*	
	Total	*Rural Urban (%)*	*Total*	*Rural Urban (%)*	*Total*	*Rural Urban (%)*
European						
Rural	671,980	44	696,471	35	571,030	22
Urban	847,508	56	1,307,386	65	2,071,683	78
Native						
Rural	4,110,813	87	5,455,047	83	6,233,852	73
Urban	587,000	13	1,141,642	17	2,292,228	27
Asiatic						
Rural	114,523	69	74,095	34	82,357	25
Urban	51,209	31	145,596	66	284,307	75
Coloured						
Rural	295,580	54	354,754	46	389,889	35
Urban	249,968	46	414,907	54	713,416	65

Secondly during the period 1921–36 there was a big increase in the Bantu population in the Reserves and Protectorates and particularly in the Transkei. Between 1936 and 1951, however, the population in these areas remained more or less static. Apparently the capacity of these areas to support the people had been reached and strained. At first the Bantu spilt over into the European farming areas where the 'Poor Blacks' replaced the 'Poor Whites', of an earlier period. Since 1939, however, with the development of industry in the main urban areas there has been a great movement of the Bantu to the European towns (Fig. 232), even to Cape Town, where in the past the Non-Europeans have belonged almost entirely to the Coloured group.

The drift to the towns of the Asiatics is relatively more striking although the numbers involved are smaller. The great change occurred in the 1921–36 period when the Indians left the sugar cane plantations to take up work in trade and industry in the towns. Since 1936 the Indian urban population has doubled. During the same period the rural population has increased slightly being supported by the enlarged markets for vegetables, bananas, and other fruits in the production of which it is mainly engaged.

Population Problems and Racial Policies

The rapid increase in all sections of the population and the overall very much greater increase in the number of Non-Europeans compared with that of the Europeans has given rise to serious population problems and has very largely dictated the racial policy of the Union of South Africa.

The problems derive in the first instance from the fact that the land cannot support any racial group entirely in agriculture. Some people must work in mines,

industry, or commerce and must live in towns. But the Europeans consider the towns as their own particular creation. Problems first arose towards the end of the nineteenth century when the Indians moved to the Witwatersrand where their insanitary habits and the outbreak of plague in their quarters led to the attempt to confine them in locations (see ch. 6, p. 112). This marked the beginning of the urban segregation of the races. After the passing of the Natives Land Act in 1913

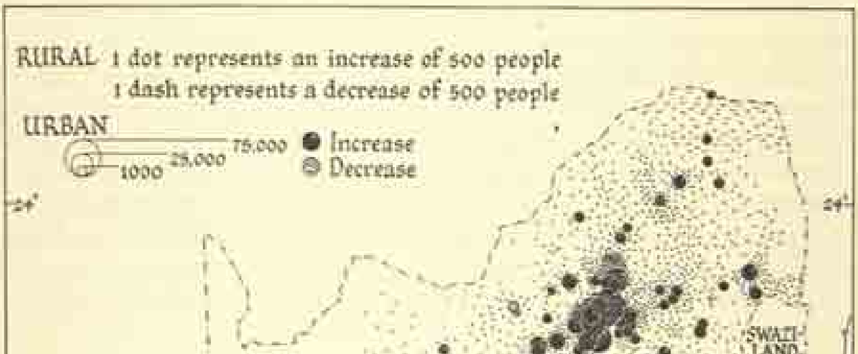


Fig. 232. The changes in the distribution of the Bantu population, 1936–51.

a steady stream of detribalized Bantu folk began to pour into the towns where they threatened to lower the Coloured man's standard and ultimately the White man's too. Instead of trying to raise the level of the Bantu the poorer section of the European community, fearing their competition, fought for their exclusion from skilled jobs and even from semi-skilled and unskilled work as well, and demanded residential segregation. Hence in 1923 the Urban Areas Act was passed. This laid down a uniform pass law outside the Cape and empowered

the municipalities to set aside locations where the Natives would enjoy a measure of local self-government and security of tenure short of freehold. The most serious problems, however, have arisen since 1939 with the mass migration of the Bantu to the towns which has paralleled the unprecedented growth of industry. The increase in their numbers and the impoverishment of the Reserves due to bad farming and severe soil erosion (see ch. 34) made the seeking of employment in European areas necessary. The development of industry provided the opportunity. Because of the scale of the migration serious overcrowding in the existing Native townships, the growth of shanty towns, the overloading and congestion of existing transport facilities, and appalling social problems followed. Again the White man's standards were threatened and in the Cape that of the Coloured man too. The solution has been sought on the one hand in the Group Areas Act of 1950 which aims at separate townships for each racial group within the urban areas and on the other in a policy of development for the Bantu territories (see ch. 34, p. 524) which it is hoped may become self-supporting so that the drift to the European towns may be arrested and even reversed.

44

The National Income, Trade, and the Balance of Payments

The economic progress achieved by the Union of South Africa during the past forty years is summarized in the growth of national income (Table 36), and in the changes in the relative contributions made by agriculture, mining, and manufacturing industry. Since the end of the first world war the national income has multiplied nearly tenfold, which even when allowance is made for the depreciation in the value of money reflects remarkable progress. Since 1938–9, while the value of the £ has about halved, the increase in the national income has been fourfold and during the past decade alone it has doubled.

Table 36. The National Income of the Union of South Africa 1917–18 to 1955–6[1]

	1917–18 £ million	%	*1938–9 £ million*	%	*1945–6 £ million*	%	*1955–6 £ million*	%
Agriculture	36·9	21·6	50·0	12·7	82·2	11·7	251·7	14·4
Mining	34·7	20·3	81·5	20·6	95·0	13·5	231·1	13·2
Manufacturing	16·4	9·6	69·7	17·7	140·0	19·9	409·6	23·4
Trade	26·6	15·6	53·8	13·6	113·3	16·1	224·0	12·8
Other	56·3	32·9	139·8	35·4	273·3	38·9	635·5	36·3
Total Geographical Income	170·9		394·8		703·8		1,751·9	
Rest of World					54·6		206·2	
Net National Income					649·2		1,545·7	

During the inter-war years mining maintained its position as the backbone of South African economic life. Secondary industry developed steadily contributing an increasing share of the national income while the value of agricultural production declined relatively, largely because of low wool and maize prices during and following the Great Depression. Since 1939 the relative position has changed dramatically, both manufacturing and agriculture now contributing a

larger share than mining. Rapid growth during the war and post-war years is responsible for the fact that manufacturing industries now contribute a larger share of the national income than any other form of enterprise, while the advance in the value of agricultural output is due partly to the high prices for wool, fruits, and maize, and partly to the greatly increased agricultural production resulting from changes in the agricultural economy and more intensive use of the land. The relative decline in mining is, however, more apparent than real. Increased mining activity and particularly the development of the Orange Free State and Klerksdorp goldfields has in large measure supported the growth of industry. The goldfields still form the backbone of the South African economy and gold is overwhelmingly the leading export. The relative decline in its contribution to the national income is due almost entirely to the fact that whereas prices have risen generally the world price of gold has remained fixed at the pre-war figure of $35 per ounce.

The growth in the external trade of South Africa is equally striking (Figs. 233 and 234) the value of imports having risen from about £50 million in 1919 to £443 million in 1954 and the value of exports from about £100 million to £430 million in the same period.[a] Throughout the period there has been little change in the general pattern of the trade, but there have been some significant changes in regard to certain items. Thus South Africa remains essentially an exporter of gold, wool, and other minerals and agricultural products and an importer of manufactured goods. But since 1939 there has been a marked rise in the imports of fuel oil both for internal consumption and bunkering while imports of manufactured goods have been of a more restricted and specialized nature, as home

Table 37. Union of South Africa. Value of Imports and Exports by Country (excluding Gold Bullion and Specie). 1938 and 1954 (£ million)

	Imports (excluding Government stores)		*Exports*	
	1938	*1954*	*1938*	*1954*
United Kingdom	41·4	133·8	82·3	77·7
Southern Rhodesia	0·5	8·7	1·4	27·7
Northern Rhodesia	0·3	5·0	0·7	15·2
Other African Territories	1·5	27·5	3·0	21·1
U.S.A.	16·7	83·0	0·7	20·7
Canada	3·4	15·2	0·4	1·6
Germany	7·7	19·4	5·0	14·9
France	1·1	5·7	2·1	13·2
Netherlands	1·5	8·6	0·4	7·6
Belgium	3·3	7·2		9·4
Total – British Commonwealth	51·1	205·1	86·6	153·5
Total – All Countries	95·8	412·6	104·1	317·9

industries have increasingly been able to supply goods hitherto imported. Thus there has been a continuing large import of textiles but a steady reduction to almost negligible proportions in the import of clothing. Vehicles and machinery of a specialized nature figure largely in the import trade but the Iscor iron and steel works now provide over 80 per cent of the country's iron and steel requirements and only small quantities of special steels are still imported. The export trade is still dominated by gold and wool but uranium exports rose from nil in 1951 to £39 million in 1956, the export of machinery, gold plate, and jewellery, clothing, and other manufactured goods has begun and there have been marked increases in the export of dessert fruits, canned fruits, and jam. Overall trade is becoming more diversified although still dominated by one or two items.

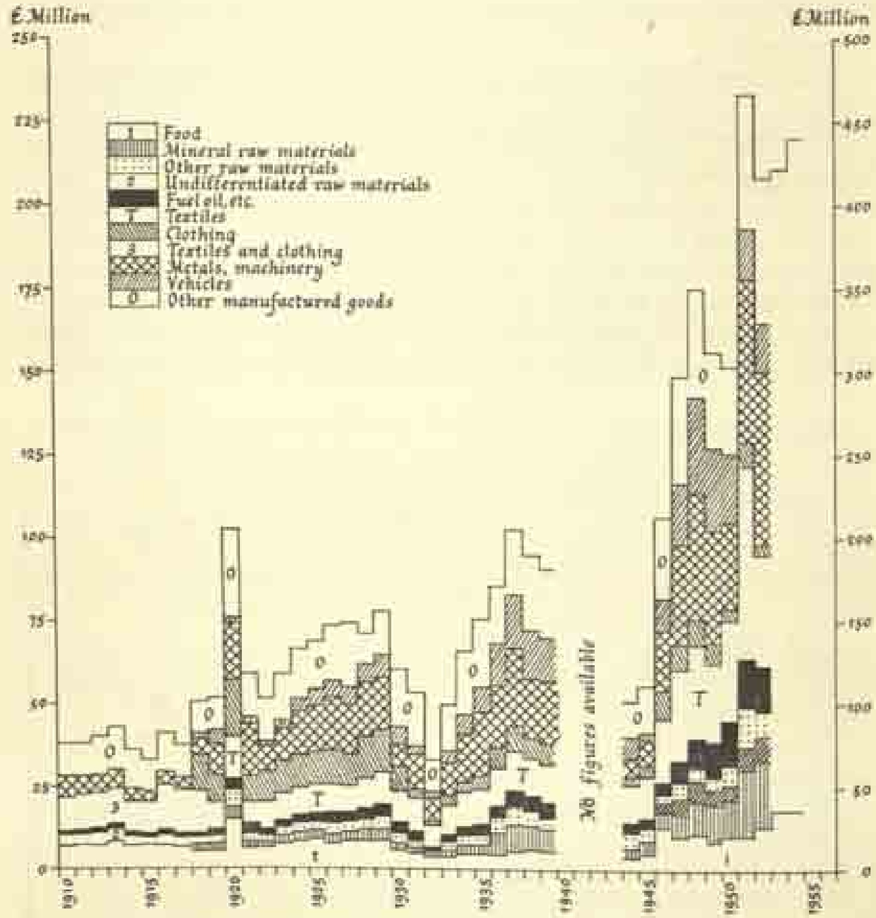


Fig. 233. Imports into the Union of South Africa, 1910–54.
Note change of scale between 1939 and 1944.

Before the second world war South Africa's trade was conducted almost entirely with the United Kingdom. The U.K. still is South Africa's best customer, excluding gold bullion, taking more than 25 per cent by value of her exports, mainly foodstuffs and minerals, and providing over 33 per cent by value of her imports, mainly machinery, textiles and other manufactured goods. But since the war the trade circle has considerably widened (Table 37). Trade with the Rhodesias and other African territories has been steadily increasing for many years and now (1954 figures) nearly 19 per cent of South African exports by value go northwards. These consist almost entirely of machinery, clothing and other manufactured goods. Very little, however, is imported from these territories. South Africa also has a flourishing export trade, mainly in wool and crayfish, with

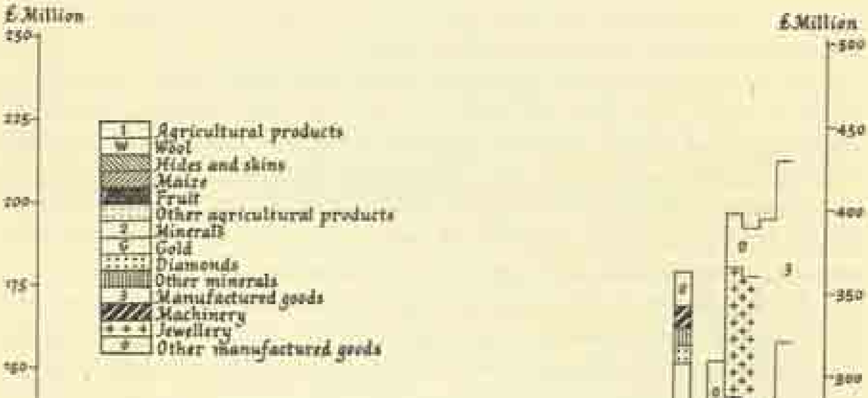


Fig. 234. Exports from the Union of South Africa, 1910-54.
Note the change of scale between 1939 and 1944.

France and in wool, fruits and minerals with Germany, the Netherlands, and Belgium. In return she imports machinery particularly from Germany and textiles from France. Since 1939 trade with the U.S.A. has increased rapidly. During the past few years the U.S.A. has provided around 20 per cent by value of South Africa's imports, mainly mining machinery and railway equipment, and has taken from South Africa increasing quantities of uranium oxide and mineral ores, as well as small quantities of dessert fruit, canned fruits, etc. The apparent lack of balance in South Africa's trade both with the U.K. and the U.S.A. is rectified by exports of gold bullion and specie, sales to the U.K. totalling £101 million in 1954, £95 million in 1955 and £103 million in 1956. In 1956 gold to the value of £90 million was sold to other countries, mainly the U.S.A.

The expansion of trade since the end of the second world war has taken place in spite of difficulties in the immediate post-war period which necessitated the imposition of import control measures in 1948.

As a result of restricted trading during the war, South Africa had accumulated by 1945 a large pent-up demand for imports, both consumer goods and capital goods, to exploit the wide range of investment opportunities in almost every sphere of economic activity. Considerable funds were available to finance these purchases. At the end of 1945 the South African Reserve Bank's holdings of gold and foreign exchange totalled £267 million and stood to be reinforced by an annual gold output worth approximately £100 million.

In 1945 imports from overseas amounted to £112 million. In 1946 they rose by £100 million and reserves fell by £146 million. In 1947 imports reached £303 million but the drain on reserves was offset to a large extent by a notable inflow of capital mainly from the U.K., which began in that year and continued until 1954. Net capital imports in 1947 were estimated at £182 million and the loss of reserves was only £3 million. In 1948, however, imports reached a record figure of £354 million and the capital inflow, though still substantial at £91 million, did not prevent a fall in reserves of £84 million. In order to arrest further drains on the reserves the South African Government began to impose import controls in the autumn of 1948. At this stage it should be emphasized that it has been a considerable misfortune to South Africa that the world price of her most valuable export, namely gold, has remained fixed at the pre-war figure. If the post-war price of gold had risen as compared with pre-war by no more than the increase in the cost of production, most of South Africa's balance of payments problems would have been avoided.[1]

Since 1948, however, due mainly to a combination of enterprising capital development, sensible official policy, and some good fortune, these problems have been largely overcome and during recent years the Union's economic situation has gone from strength to strength. Whereas in 1948 there was an adverse balance on the merchandise account of £222 million, by 1956 this had fallen to £92 million and despite the fact that capital imports had ceased the gold and foreign exchange reserves rose by £8 million.

This remarkable change has been due to a number of factors. Wise Government policy has played a major role. It was obvious in 1948 and 1949 that the excessive demand for imports was due to inflation or an excessive supply of purchasing power in relation to the goods available. This could be overcome either by restricting the supply of money or, if possible, by increasing the supply of goods or any combination of the two. Import control, however, necessary for balance of payment purposes, tends to aggravate inflationary conditions. Deliberate restrictions on the supply of money in a country, or deflation, discourage commercial enterprise and are particularly undesirable in a young and developing country like South Africa. The Government, however, managed to steer a middle course. In this it was helped by the fact that South Africa is practically self-sufficient in foodstuffs. Imports consisted mainly of two categories of goods, capital goods for development and raw materials for manufacturing on the one hand, and on the other inessential consumer goods. By largely prohibiting imports in the latter class it was possible to make substantial reductions in the total imports without restricting imports necessary for industry and development. Moreover, at the same time, while the restrictions on imports of consumer goods tended to increase inflationary trends, it also acted as a form of protection for infant industries, so that today a wide range of articles formerly imported are now made locally. Moreover, with regard to the supply of money, the Government adopted measures designed to encourage productive enterprise. From time to time it requested the commercial banks to restrict the supply of credit for less essential purposes. South Africa was also one of the first countries to use the weapon of interest rates to combat inflation. Throughout the period the aim of the Government was to cure inflation by increased production rather than by mere restriction, and wherever the position so justified the Government readily relaxed restrictions.

The measures adopted by the Government not only stimulated home industries, but encouraged the inflow of private capital for productive effort. At the same time industrial production was stimulated, as elsewhere in the world, by the generally higher prices which have prevailed since the war. The increase in production has been widely spread and includes gold and many other minerals, agricultural products, and manufactured goods. The output of gold rose from about £100 million in 1948 to £199 million in 1956. Uranium exports rose from nil in 1951 to £39 million in 1956. Coal sales increased from 26 million tons in 1946 to 36 million tons in 1956, and permitted the more-than-doubling of the electricity output over the same period. New basic industries such as the production of oil-from-coal (Sasol), the manufacture of textiles, wood pulp, and paper, etc., were established while existing industries expanded their output and range of activity. The fishing industry was developed and there were substantial increases in the production of maize, wheat, fruit, sugar, oilseeds, and other crops.

As a result of the greatly increased production the value of exports,

exclusive of gold, rose from £132 million in 1948 to £413 million in 1956, an increase of over 200 per cent over a period in which the rise of prices was not much more than 50 per cent. In 1957 exports are expected to exceed £450 million exclusive of gold and over £660 million inclusive of gold. On the other hand imports have risen only from £354 million in 1948 to £494 million in 1956, an increase of about 40 per cent which, allowing for price movements, suggests some fall in the volume of goods imported. By 1956 import control had been greatly relaxed, by 1957 only about 10 per cent of the estimated imports were still controlled and the Government had indicated its intention of abolishing import control entirely sometime in 1958.[4]

Throughout the post-war years South Africa has maintained close relations with the United Kingdom financial authorities.

The arrangements prior to the second world war, which date from the formation of the South African Reserve Bank in 1925, provided for the sale by South Africa to the Bank of England of sufficient gold to cover the Union's foreign exchange requirements, any non-sterling currency being provided from the sterling area pool. An agreement in 1946 fixed these sales at a minimum figure of £70 million a year for 1946 and 1947, an amount which appeared at the time to be rather more than necessary to satisfy current requirements. As it turned out, drawings of hard currency from the London pool considerably exceeded the gold provided to cover them, and late in 1947 South Africa agreed to lend the United Kingdom £80 million in gold (actually transferred early in 1948) to assist the sterling area's reserve position. At the same time the Union Government agreed to pay in gold for any dollar drawings on the reserves. The worsening of South Africa's balance of payments position in 1948–9, however, compelled her to ask for repayment of the gold loan in sterling, and this was effected in 1949.

When, from 1948 onwards, it became necessary for the Union to impose import controls, these also were devised so as to assist the sterling area generally by discriminating against imports from hard currency areas. An agreement early in 1950 placed arrangements on a footing which was maintained until 1954. By this agreement South African imports were divided into two classes, essential and inessential. All were subject to licence, but essential goods could be imported from any country able to supply them and were to be paid for in gold. Inessential goods could be imported only from soft currency areas. An amplification of the agreement later in the year envisaged that sales of gold from the Union to the United Kingdom would not be less than £50 million per annum. In fact, the Union's contributions to the gold and dollar reserves in the four years 1950 to 1953 inclusive totalled £279 million or approximately £70 million a year. In 1954, all discrimination against hard currency imports was removed, and as from the beginning of 1955 the agreement fixing a minimum amount of gold to be sold to the Bank of England was allowed to lapse by mutual consent. In spite of these relaxations in control, net gold sales to the United Kingdom continued at a high level – £101 million in 1954, £95 million in 1955, and £103 million in 1956.

Largely as a result of the sales of gold to the United Kingdom, South Africa has enjoyed the unrestricted flow of capital over the period 1946 to 1954. Sterling capital entering the country in that period is estimated to have totalled £504 million, out of a total capital inflow from all sources in the same period of £639 million. That the capital has mostly been invested on a profitable basis is shown in the figures of net investment income remitted overseas by South Africa, which have risen from £24 million in 1946 to £58 million in 1955. As from 1954 the capital inflow has virtually ceased, at any rate for the time being, but its effects continue. It has, broadly speaking, made South Africa financially independent. Moreover, the increase in production which overseas capital helped to bring about is resulting in surpluses which are available for local investment. South Africa is now providing her own capital requirements to an increasing extent. No doubt development would go ahead more rapidly if the capital inflow were resumed but present appearances suggest that a satisfactory rate of progress can be maintained without aid from overseas.

BIBLIOGRAPHY

1. Bureau of Census and Statistics.
2. Union of South Africa Yearbooks.
3. *Barclays Bank Review*, Aug. 1957.
4. *South African Progress*. Bulletin issued by the Director of Information, South Africa House, London. Sept.–Oct. 1957.

45

The Future

The Union of South Africa today is beset with many problems, in the solution of which she stands at the cross roads. The pioneer stage of land occupation is passed and agriculture is passing from extensive ranching or maize monoculture to the stage of more intensive land use and mixed livestock and arable farming. Although still dependent on mining for much of her wealth South Africa has already emerged as an industrial nation. Although primary products – gold, diamonds, wool, maize – still account for the major part of the export trade, exports of manufactured goods are increasing and yearly bringing in a larger share of the income. The major problems concerning the whole future of the country hinge on the relative roles of agriculture, mining and industry, the deployment of the resources of European and Non-European labour, the distribution of industrial enterprise, and the acceptance of rigid Apartheid or of some form of racial integration as the policy of the country. In all these issues the neighbouring Protectorates are deeply concerned since their people depend very largely on the Union mines and factories for temporary employment. Here too the issue regarding the transfer of the Protectorates to the Union or their continuance directly under the British Crown is involved.

Compared with other countries the agricultural productivity of South Africa is very low. Recurrent droughts severely handicap both arable and pastoral pursuits reducing crop yields and causing heavy stock losses, but even in good years crop yields are very low compared with those of other countries while the livestock enterprises leave much to be desired. With better seed, adequate fertilization of the soil and a proper rotation of crops, yields could be and in some cases are being increased. Much could be done to prevent overgrazing and soil erosion. By the use of fertilizers and the introduction of paddocking and rotational grazing the quality of the pasturage could be greatly improved, and with the provision of fodder and control of disease better animals could be kept. There are few opportunities for any great increase in the areas under irrigation in the drier parts of the country, but by a closer integration of crop and livestock enterprises, the productive capacity of the better watered areas could be considerably increased. Trends in all these directions are in fact evident, but from the very

nature of the climatic conditions and the general inherent poverty of soil, South Africa is unlikely to become a rich agricultural land. Moreover as the mechanization of agriculture becomes more widespread the employment opportunities will naturally diminish, so that alternative outlets for the growing population are essential.

With the Witwatersrand Goldfield still yielding gold, the Free State and Klerksdorp fields at the beginning of their productive life, and exploratory work progressing in the eastern Transvaal, the economy of South Africa still rests on gold and is likely to do so for many years to come. The gold mining industry, however, is faced with the problem of rising production costs while the world price of gold remains fixed. Labour, drawn largely from African territories outside the Union, is increasingly difficult to obtain, is of a migratory nature and will become scarcer as the development of these territories proceeds. The rising costs of gold production may be offset by the returns from uranium extraction. Labour problems may be relieved by increased mechanization. A permanent semi-skilled labour force may be built up as a result of the attraction of family houses for African workers provided on some of the Free State mines. The crucial issue – the fixed price of gold connected with its function as the basis of international currency – however remains.

More than thirty years ago it was recognized that industrial development was essential to provide employment for the increasing 'Poor White' population for whom the land and the mines could not provide support. Under tariff protection many industries were started but it was only with the state-aided establishment of basic industries such as iron and steel production, the protection accorded by the second world war, and especially the introduction of mass production methods permitting the employment of unskilled or semi-skilled Africans that real progress was made and the manufacturing enterprises put on a competitive footing with overseas concerns. Industrial development has greatly benefited both agriculture and mining as well as providing much needed employment for both European and Non-European people. But it has brought with it tremendous problems.

The outstanding problem connected with industrial development has been the influx of Africans into the European towns. The lack of adequate housing for these people and the growth of shanty towns, serious though they be, are really side issues. The crucial one is the 'invasion of the White Man's Territory' to the extent that in some towns, e.g. Durban, Johannesburg, the Non-Europeans now outnumber the Europeans. This issue has very largely prompted the Apartheid measures introduced by the Nationalist Government, e.g. the Group Areas Act and the attempt to close employment in some industries, e.g. clothing manufacture, to Africans.

At the same time it is recognized that the Native Reserves in the Union are incapable of supporting all the Bantu population in agriculture, that Native agriculture is backward, wasteful, destructive of soil and land, and that most of

the reserves require rehabilitation. Additional areas are required for Native occupance but in the national interest the acceptance and practice of better methods of husbandry by the Bantu farmers is an essential pre-requisite. Most thinking people now realize that alternative forms of employment are essential for the increasing Bantu population. Today the urgent need is for industrial employment for the 'Poor Blacks' as thirty years ago it was necessary for the 'Poor Whites'.

The solution to these problems is seen in the development of industry in and on the borders of the reserves where the geographical conditions, moreover, are favourable. This would provide the necessary employment for the Bantu and, it is hoped, arrest their drift to the European towns. Wider issues, however, are involved, questions of capital with which to start such industries and the technical knowledge and skilled labour with which to direct them. Moreover, the established industries in the European towns require unskilled Non-European labour in order to be able to compete with overseas concerns. Furthermore, once similar modern industries are established in the reserves, it is dubious whether the European-run industries will be able to compete with them. In any event, the success of any industrial development depends in the first instance on suitable location, and hence the industrial future of South Africa must be governed by geographical considerations.

The British Protectorates are intimately concerned in all these issues. Poor in natural resources they cannot support their present population and the opportunities for economic advancement are very limited. Economically they depend on the Union to which increasing numbers of their people go to work temporarily in mine and factory. Indeed the main export of Swaziland and Bechuanaland no less than that of Basutoland is labour. Provisions were made in the Act of Union 1910 for the ultimate transfer of these territories to the Union. But since then the policy of racial segregation within the Union has hardened feeling against any such transfer and the avowed policy of Apartheid presents an insuperable barrier.

These then are the major problems confronting South Africa today. In many ways the Union stands at the cross-roads. In the midst of agrarian and industrial revolutions she faces a social one as well. This challenge must be considered against the whole geographical background and the relative merits of Apartheid or some form of racial integration must be carefully assessed in the light of economic and social progress not only in South Africa but in the world as a whole.

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